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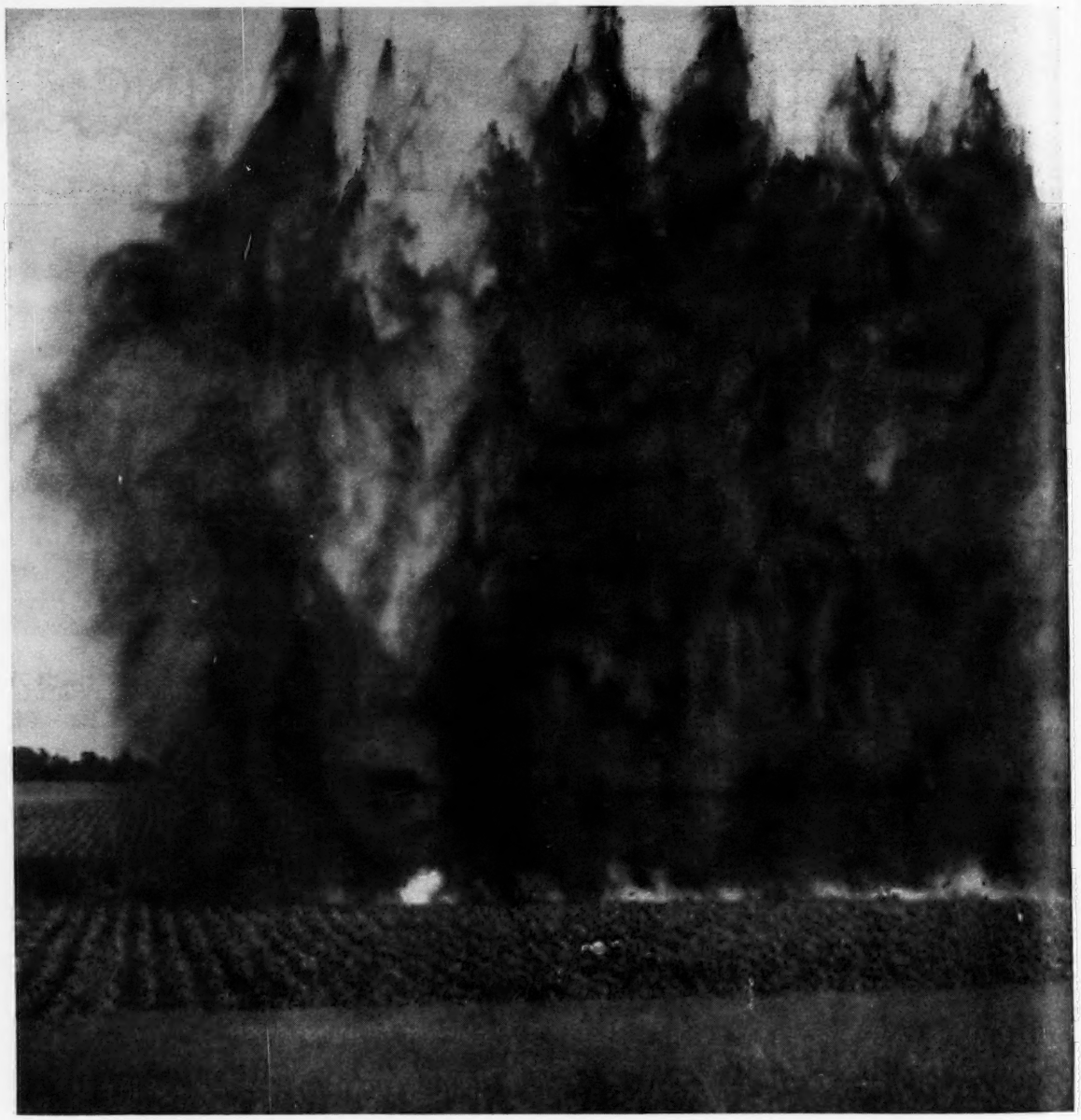

Instantaneous Power

SOME farm jobs of breaking up, loosening, or moving materials may be most economically performed, under some conditions, by a single application of concentrated power. A superlative example of this form of power application is the propagation method of ditch blasting for original construction or cleanout. This picture shows one end of a progagated cleanout shot using 600 sticks of dynamite on 900 feet of ditch, in Du Page County, Illinois. Characteristics of explosives, safety considerations and precautions, and methods of application for maximum useful effect under specific combinations of conditions and objectives have been well worked out by explosives manufacturers. Progress in these matters is continuing.

Agricultural engineers might well give increased consideration to the technology and operating economics of explosives as a tool for accomplishing certain farm improvement work. Economical use of explosives depends on accurate specification of the job to be done, the operating conditions, the minimum loading which will do the job, and comparison of estimated overall costs with those of other possible methods of doing the same job. The aggregate of large and small farm improvement jobs to be done would justify agricultural engineers in drawing a fine line between optional methods and power applications as to relative advantages and disadvantages for various combinations of jobs and conditions, as a basis for recommendations to farmers.

AGRICULTURAL ENGINEERING

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Criteria of a Profession

AS REPRESENTATIVES of a new and distinct branch of a profession which is itself a youngster among the learned professions, agricultural engineers are in a position to profit by frequent professional introspection. Do they measure up to professional standards of training, ideals, and performance? How can they be of greatest possible credit to the engineering profession? A basis for self-judgment in these matters is provided in the address of Dr. Vannevar Bush, before the last American Engineering Council meeting, entitled "The Qualities of a Profession."

Dr. Bush indicates that true profession is distinguished by having, as its primary objective, ministration to the people. It ministers to the people with "dignity and authority . . . . by right of superior specialized knowledge . . . . as the people allow it to maintain its prerogatives by reason of confidence in its integrity and belief in its general beneficence." He believes that "the great mission of the engineer lies in intelligent, aggressive, devoted ministration to the people."

In the long history of professional development, groups have "remained high in the esteem of the people and have endured" so long as they continued to minister to the people, and have soon disappeared when they gave precedence to other objectives, as in the case of militant orders devoted to self-aggrandizement.

Any lesser objective on the part of engineers will result, Dr. Bush believes, in "gradual absorption as controlled employees, ... disappearance of our independence . . . . (in engineers becoming) merely one more group of the population, trained with a special skill, maintaining our economic status by a continuing struggle against the interests of other groups, forced in this direction and that by the conflict between the great forces of a civilized community; with no higher ideals than to serve as directed, and with no greater satisfaction than the securing of an adequate income as one member in the struggle for the profits of an industrial age."

"Are the things that engineers do so vital that they must be approached in the professional spirit?" Most engineers will presumably agree with Dr. Bush that, considering the variety, extent, and complexity of engineering influences on life, "there was never a profession that more truly needed the professional spirit, if the welfare of man is to be preserved."

A profession being justified, and its primary objective understood, how is it perpetuated and its reputation and ideals preserved? It exercises a measure of self-government according to its needs, over and above such legal controls of its practice as may be provided by the people to whom it ministers. It maintains a voluntary organization, with high standards of admission to its higher grades of membership, to foster technical proficiency and professional idealism. Its members in the teaching profession exercise a measure of initial selection of candidates for the profession. They teach ideals as well as technology. Ritual, symbolism, customs, degrees, honors, and other identifications help build professional consciousness. And the leaders of the profession, under whose guidance its younger men work, exert an inspirational, ethical, and otherwise maturing influence which finally prepares some individuals for similar leadership.

In the case of engineering, each branch has its professional organization through which its leaders work to perpetuate and improve its ministration to the people. But none of these can speak for the engineering profession as a whole. For "giving thought and voice to their position in society, and to their responsibility for the use of the great works which they create," they have a central organization, the American Engineering Council. "Here, more than in any other organization reside the external as contrasted with the internal relationships of the profession . . . . . if it fails, and if its place is not taken by a more rugged successor, there will be no unitary engineering profession at all."

Agricultural engineers may well judge themselves, their branch of engineering, and the whole engineering profession, and likewise let their branch of engineering be judged by others, particularly leaders in other branches of engineering, by these criteria presented by Dr. Bush—an objective of ministry to the people, a field of work justifying professional spirit, provision for selection, development, and perpetuation of professional personnel, and contribution to engineering unity in external relations, through the American Engineering Council.

Professional Status of Agricultural Engineering

IN THE preceding editorial we reviewed the criteria of a profession offered by Dr. Bush, and suggested it as a basis of judgment of agricultural engineering as a branch of the engineering profession. We now present one such judgment, for whatever kicking around it may be able to stand.

Farmers were the first to discover and indicate that they needed technical engineering service. The initiative shown by some of them in trying to improve their use of land and water resources, buildings, equipment, power applications, and living and working conditions resulted in queries to public agricultural and engineering agencies and to manufacturers of materials and equipment. The number of such queries is increasing as more farmers learn of the assistance available, and as the personnel, background, and facilities for giving such assistance are developed and increased. Unquestionably agricultural engineering arises out of a basic need expressed by farmers. It has a group to whom to minister.

In attempting to minister to this group in engineering matters, engineers trained in the fundamental, technical branches of engineering found that solution of agriculture's engineering problems required, in addition to common engineering applications, data, and paraphernalia, some new applications of the laws of science with which they were familiar, new data and devices they did not have, some sections of their basic sciences not used in other branches of engineering, and some branches of science scarcely used at all in other branches of engineering. As more engineers were called upon to devote more time to the special engineering problems of agriculture, a body of knowledge on engineering applications of science to agriculture began to

develop. This differentiation of the science applied, plus the unique considerations of the art and business to which it is applied, justifies the degree and direction of technical specialization represented in agricultural engineering today, after more than thirty years of development and increasing usefulness. Agricultural engineers have a distinct body of specialized knowledge to be administered.

Agriculture is the well-known original and basic industry, the foundation of urban industry and culture. It involves a tremendous aggregate of production, power utilization, movement of materials, and environmental controls, still operating at low average efficiency and high human cost. Technological progress in agriculture influences the living and working conditions of farmers' families, their health and occupational hazards, their earning capacities, social life, educational opportunities, viewpoints and even their spiritual development. It influences population and production trends. Technology is with agriculture to stay. Neither paternalism, neglect, nor limited technical advice on narrow phases of its broad engineering problems will meet the needs of agriculture. Engineering counsel on a professional plane is warranted and agricultural engineers are trying to meet this need.

The professional standards of agricultural engineers in their relations with other branches of engineering, agricultural scientists, farmers, and the general public may be dismissed here with mere mention of their record as cooperators and their long continued support of American Engineering Council, in principle and in fact, financially and through the thought and work of their representatives on that august body.

While stoutly justifying agricultural engineering as to the need, extent, and direction of the professional specialization represented, leading agricultural engineers have been duly humble before the task of building a personnel and technology which will measure up to engineering professional standards and agriculture's requirements. They have been constructively self-critical as to their performance. With a continuation of this healthy attitude, we believe that agricultural engineering should mature and endure as a creditable branch of a respected profession.

Prospective Results of Research

RECENTLY we were asked by a banker to venture an opinion on "What important developments will assert themselves in your field as a result of research in the next few years?"

Foresight being less accurate but generally more profitable than hindsight, we ventured a prediction and reproduce it here by way of suggesting additional thought on the subject by agricultural engineers.

"Agricultural engineering, in the next few years, should be characterized by a close follow-up and application of the research results of the sciences on which it is based.

"Some scientists in nutrition, organic chemistry, and physics are taking various farm commodities and asking themselves, for each one, 'Of what use is it to man, and why, and how could it be made more useful?' Their research answers their question in the specific terms of chemical organization and physical structure of the commodity in relation to its properties and use purposes.

"Some biological scientists then ask themselves, in effect, 'How does it get that way?' Their research gives the answer in terms of the hereditary characteristics of living cells, and of the influence on cell life, growth, productive activity, and product quality of such environmental factors as soil composition and structure, temperature, water supply, atmosphere, light, and the presence of disease organisms, insects, and weeds, both during growth and in necessary handling, preparation, and storage of the product before it is used.

"Agricultural engineers, in turn, then consider, 'How can this maximum human use value be created by the farmer in practical operation at the lowest human cost in consideration of what can be done (1) to control the environment of crop and animal production and preparation for market, (2) to enable the farmer to use more low-cost mechanical power and less high-cost human muscular energy in his operations to control biological production conditions and to prepare the resulting products for market, and (3) to make available to him improved working and living conditions?'

"The answer, in the next few years, in the four major branches of agricultural engineering may be expected to include the following:

"1 *Power and Machinery.* Improved methods and field equipment for maintaining soil conditions at specified optimums for specific crops. Improved methods and equipment for harvesting crops and preparing them for use on the farm or for cash sale. More versatile and easily controlled motors and tractors, and more total horsepower per farmer.

"2 *Soil and Water Conservation.* Better control of water for crop use, with reduced waste of both water and soil, in irrigation and drainage. Increased supplemental irrigation in humid regions for crops of high unit value.

3 *"Farm Structures.* Application of material and design combinations, including insulation and varying degrees of air conditioning, to meet more accurately specified requirements for animal and equipment shelter, crop storage, sanitation, fire prevention, and economy of indoor operations.

4 *Rural Electrification.* Improved and extended applications of light for seeing. Application of various portions of the spectrum for biological effects in specialized production, including use of radiant heat, control of plant maturity, and killing of pathogenic organisms. A greater variety of power and heating applications where automatic operation and accurate control are at a premium. Use of other electrical effects, as, for example, use of shock in fences for control of domestic animals, and in traps for insect pests.

"In connection with old and new applications in all of the above four fields, principles of production engineering will be developed and available to increase the overall efficiency of any farm enterprise through balanced investment in land, buildings, and equipment units; farmstead and field arrangement for operating efficiency; planning operations to minimize labor peaks; elimination of unprofitable operations; cost accounting; improved quality of product; reduced waste; and increased knowledge of the use economy of various types of buildings and equipment.

"Research in agricultural engineering and in the sciences on which it is based will widen the variety of crops and livestock available for farm production; enable farmers in some lines to increase their service of production, marketing their products more nearly in condition for consumer use; and decrease their production costs, providing a more satisfactory operating income while at the same time expanding their markets by decreasing the cost of food to consumers, and of fats, proteins, carbohydrates, fibers, and various chemical derivatives as industrial raw materials.

"These developments will not be completed in the years immediately ahead, but it seems likely that the important developments of the next few years will be in this direction."

A National Terrace Classification

By C. L. Hamilton

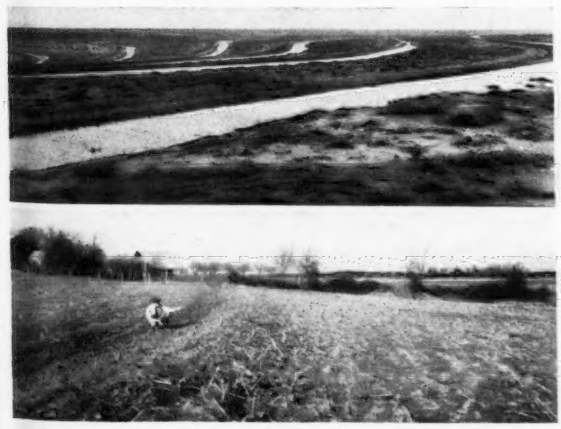
THE PRESENT development of terracing in America is the result of years of use, extensive field observations and experimentation, and many modifications from early practices in construction procedure. All stages of development from the modern terrace of today to the crude hillside ditches and furrows of pioneer American farmers have been experienced. The evolution through which terrace development has passed has led to a variety of terrace types, terms, and classifications. At the present time there does not seem to be any universally accepted terrace classification or interpretation of terracing terms. This condition is largely due to the past practice of designating terrace types according to the method of construction or the individual that developed various improvements in construction technique. Since terrace construction methods have been continually changing in the past and will probably continue to change in the future, as new improvements develop, they do not provide a stable basis upon which to develop a satisfactory classification. The lack of a nationally accepted terrace classification has led to much confusion and misinterpretation between those interested in terracing work in various parts of the country.

In some sections terraces are designated as narrow or broadbase, but a narrow or broadbase terrace as used in one area may have quite different cross-sectional dimensions from terraces with similar names in other areas. In other sections terraces are referred to as Nichols or Mangum, modified Nichols or modified Mangum. More recently we have heard of the Reddick terrace and the Georgia terrace. The Wheatland terrace and the row terrace, the level terrace and the graded terrace, the ridge terrace and the channel terrace are some of the other terms being used to describe terraces in certain sections of the country. There is no clear understanding as to the fundamental differences in many of these terraces, and investigation shows that many of the local terms merely designate similar types of terraces. Further development of terracing work, from either a national or sectional viewpoint, is severely handicapped by this lack of unification, and therein lies a field badly in need of constructive thought and basic coordination. It is somewhat surprising to realize that America's agricultural engineers, who have been closely associated with and keenly interested in the development of terracing, have, to a large extent, either neglected or overlooked this phase of their work for many years.

Expanded and coordinated erosion programs and the concentration of more engineering thought on terracing work during the last few years has already reflected some progress in terrace classification development. Many agricultural engineers in soil conservation work now believe that the only logical procedure is to base the main classification on the manner in which terraces function. The principal terrace functions can be defined; they have been well established for many years, and the likelihood of change in the future is slight. This provides the necessary stability upon which a classification that is to remain permanent must be built. Merely adjusting terrace cross-sectional dimensions to harmonize with the size of tillage equipment used in the respective area does not constitute the development of a new type of terrace so long as it performs the same basic function. In the past, terraces which merely had different cross-sectional dimensions have often been considered as distinctly different types. The ultimate objective of all terraces is soil conservation, but they can attain this objective in three distinct ways: (1) By controlling surface drainage, (2) by increasing rainfall absorption, and (3) by reducing surface slopes. This provides the basis for three corresponding basic terrace classifications: (1) The drainage type terrace, (2) the absorptive type terrace, and (3) the bench type terrace. (Some may prefer to call the drainage type terrace a diversion type terrace and the absorptive type terrace a retention type terrace.)

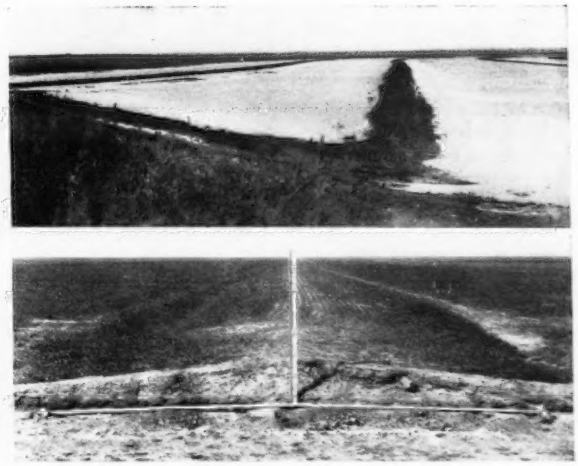
Approved by the U. S. Soil Conservation Service for publication in AGRICULTURAL ENGINEERING.

Author: Agricultural engineer, engineering section, Soil Conservation Service, U. S. Department of Agriculture. Mem. A.S.A.E.



THE DRAINAGE TYPE TERRACE

The lower view shows a desirable cross section, and the upper view shows how the runoff is slowly drained from a field during a storm



THE ABSORPTIVE TYPE TERRACE

The lower view shows a desirable cross section, and the upper view shows how the runoff is spread and retained on a field to facilitate absorption

In many sections of the country terraces will perform a dual function of both drainage and absorption, but in each section either drainage or absorption will be the principal function, and the respective terraces can be classified accordingly. The degree to which surface drainage can be secured by the absorptive terrace is determined by the extent to which the ends are blocked, while the amount of absorption secured with drainage terraces can be regulated to some extent by the steepness of the channel gradient used. Cross-sectional dimensions of all terrace types will differ throughout the country according to the soil type, terrain, rainfall characteristics, and type of machinery to be worked over them, but the fact that these dimensional adjustments must be made to meet local conditions does not change the basic type or invalidate the classification of all terraces according to function.

The Drainage Type Terrace[1]. The drainage type terrace, as the name implies, acts primarily as a drainage channel to control surface runoff, thus retarding soil erosion. This is accomplished by systematic runoff interception and discharge at nonerosive velocities. A wide, shallow channel of low gradient that has gentle side slopes and ample water capacity is used. The excavated earth forms the down-slope side of the channel and the resulting ridge should blend smoothly into the surface slope to afford a minimum of interference with tillage operations. These requirements, together with the fact that it is easier to move earth downhill than uphill, make it advantageous to construct most, if not all, of the terrace from the upper side. In the drainage type terrace, the ridge is considered as supplemental to the channel. From the construction standpoint, this type of terrace might be designated as the channel terrace or the graded terrace.

The drainage type terrace appears to have been developed and used more extensively in the United States than in any other country. From its inception in the southeastern states it spread westward into Oklahoma and Texas. After becoming established in the southern states, it gradually spread northward. As yet it has not been used very extensively in the northern or western states. During recent years the drainage type terrace has been introduced into several foreign countries. Reports from Australia, Union of South Africa, Rhodesia, and Kenya show that there has been a steady increase in the use of American terraces in these countries, since their introduction about 1930.

The Absorptive Type Terrace. For most effective absorption and moisture distribution the absorptive type terrace should retain and spread collected runoff over as wide an area as possible. The degree to which this can be attained is limited by the required construction procedure and the land slopes encountered. The land slopes should be fairly flat, preferably less than 2 to 3 per cent, because this type of terrace becomes less effective as the land slope increases. Construction from both sides is usually advisable, not only because of the flat slopes encountered, but because an embankment that extends well above the ground surface can be produced in this manner with the least excavation above it. Excessive excavation above the ridge or embankment encourages undesirable runoff concentration and uneven moisture distribution. For this type of terrace the ridge is of greater importance than the excavated channel, which is merely incidental to the construction of the ridge. From the construction standpoint, this type of terrace might be designated as the ridge terrace or the level terrace. For maximum storage capacity and absorption the ends are closed, but as a factor of safety they are usually only partially blocked and occasionally left open altogether.

This type of terracing is essentially a flood water interception and irrigation system adapted for soil and water conservation purposes. Erosion control is accomplished indirectly. The added moisture produces a soil condition that is more resistant to wind erosion and facilitates the establishment of crops and other protective vegetal coverings. While the absorptive type terrace is being used more extensively each year in the semiarid sections of this country, it is not entirely an American development. Closed contour ridges or small dikes to retain runoff and provide sufficient moisture for crop production have been used in Egypt, Anglo-Egyptian Sudan, and other older countries, so the principle involved probably originated many centuries ago. The construction procedure, however, has been improved by American effort. Improved construction methods and equipment have been developed, and the ridges located and widened to facilitate regular cropping practices and effective moisture distribution. The use of supplemental tillage practices, such as contour listing, has also made possible more effective moisture distribution.

The Bench Type Terrace. In order to control erosion on steep slopes that must be used for the production of farm crops, it is frequently necessary to develop them into a series of level or nearly level strips running across the slope. The strips are separated by almost vertical risers, which are retained by rock walls or a heavy growth of permanent vegetation. This type of terrace is known as the bench terrace and exemplifies the original meaning of the word "terrace." The use of bench terraces on steep slopes not only retards erosion losses but also facilitates cropping operations on these steep slopes. The completion of bench terraces during the initial construction operations is common in foreign countries where cheap labor is available. Where this practice has been attempted in America, it has resulted in excessive construction costs and frequently leads to unfavorable cropping conditions owing to the abrupt disturbance and distribution of the soil. The ordinary method of developing bench terraces in this country is to construct a series of small ridges at suitable intervals and grades, retain permanent vegetation on the lower side, and natural erosion together with supplemental tillage practices gradually benches the ridge intervals within a few years' time. The principal function of bench terracing is to reduce steep slopes to such a degree that erosion control and cropping practices can be made practical. Increased rainfall absorption, runoff interception, and control are facilitated by slope reduction. *(Continued on page 98)*

THE BENCH TYPE TERRACE

Note how steep slopes are changed into a series of level or nearly level strips to facilitate erosion control and tillage practices

[1]The most desirable features of both the Nichols and Mangum terraces are combined in the drainage type terrace. Mangum's principal contribution is a graded terrace that can be farmed over, and Nichols contributed the improved channel and cross section by construction from the upper side.

Low-Pressure Sprinkler Irrigation

By F. W. Duffee

THE portable rotary sprinkler system of irrigation was introduced into Wisconsin in 1933 or 1934 on one small farm and by 1937 was being used on at least 3,000 acres. This rapid expansion was due partly to the dry seasons through the period 1933 to 1937, but probably the principal reason was that this new type of irrigation could be installed at a price the farmer could afford to pay, and it did a very satisfactory job.

There are probably an additional 500 or 1000 acres being irrigated by overhead sprinkler systems of the March or Skinner type. Most of these have been in use for many years. These systems are largely confined to use on large truck gardens, while the rotary sprinkler system has so far been used largely on potatoes.

The cost of equipment per acre for the standard type of rotary sprinkler irrigation usually decreases rather rapidly up to about 50 acres, and may be as low as $25 or $30 per acre on larger areas, provided the water supply is close to the field. In some cases, the cost of the main to carry the water to the field equals or exceeds the cost of pumping and distribution equipment.

It is our belief that irrigation in the humid areas will be confined largely to high-priced crops, such as potatoes and garden or truck crops.

While at the present time most of the acreage under irrigation is composed of large unit areas, it seems likely that the total acreage of many small areas may eventually exceed the total acreage of large units. In the vicinity of every city and village are market gardeners with a few acres, which might be irrigated with profit provided a low-cost irrigation system were available. Invariably at some time during the season a shortage of rain will reduce the yield of one or more crops.

The standard rotary system is as expensive as the overhead system for areas under 10 acres. An example will illustrate: The quotation on a complete system for an area 200x400 ft, or slightly under two acres, was about $475,

Presented before the Soil and Water Conservation Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 2, 1938.

Author: Professor and head of the department of agricultural engineering, University of Wisconsin. (Fellow A.S.A.E.)

A Comparison of the Junior and Standard Rotary Sprinkler Systems

	Standard	Junior
Extreme diameter of circle covered by a sprinkler	100 ft ±	50 ft ±
Sprinkler spacing on sprinkler line	40 ft	20 ft
Spacing of sprinkler line	80 ft	40 ft
Sprinkler line pressure	35-50 lb	20-25 lb

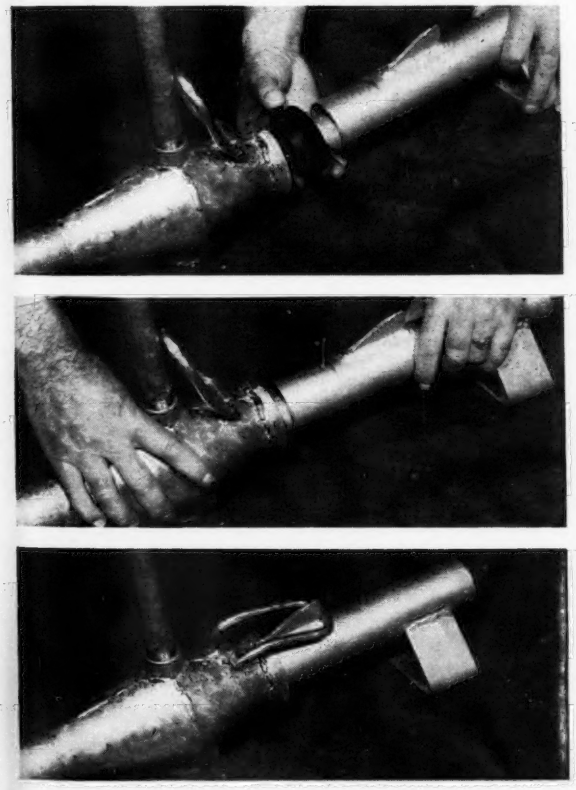


Fig. 1 A typical quick-acting, self-sealing coupling. (Top) The coupling proper, rubber gasket, and ends of tubing to be coupled. (Center) Rubber gasket inserted, ready to receive tube. (Bottom) Coupling assembled and locked

FIG. 2 A SIMPLE, EFFECTIVE, AND INEXPENSIVE ROTATING SPRINKLER IS USED AT EACH COUPLING (EVERY 20 FT). THE SPRINKLER HEADS ARE OF TYPES FOUND TO OPERATE SATISFACTORILY AT A PRESSURE OF 20 LB PER SQ IN

Fig. 3 A low-pressure sprinkler line in operation

including a 5 hp motor, suitable centrifugal pump, and a sprinkler line of 5 heads, a cost of about $250 per acre.

From this experience, we proceeded to the development of a system peculiarly adapted to areas of 10 acres or less.

When one analyzes the quoted price of a standard system against known prices of some of the units used in it, and against the prices of other semifinished parts, a rather wide discrepancy shows up between the actual selling price and what would appear to be a fair selling price.

Investigation will reveal that there is an unusually high selling cost involved, partly because of the newness of the article and apparently partly because the systems are, to a considerable extent, "tailor made" for each installation. It is true that standard parts are used, but considerable time is spent in designing and calculating each individual system. Very likely this method will have to continue for the larger systems.

In order to bring irrigation to the small user at the lowest possible cost, we have undertaken to design standardized systems, and then to offer these for sale in such a way as to keep selling costs low.

To this end we have developed the No. 1 junior system with a sprinkler line 100 ft long and carrying 5 heads; No. 2 is 200 ft long and carries 10 heads, and No. 3 is 300 ft long and will carry 15 heads.

All parts of the Nos. 1 and 2 systems are the same except the pump and power unit, and likely the same will be true of No. 3. Naturally there will be more pieces of lightweight tubing and sprinkler heads in No. 2 than in No. 1. Main line tubing can be purchased by the 20-ft length as needed. This is the only "extra."

In other words, we propose to have the junior system offered as "package merchandise," each and every system being identical and containing a fixed number of parts.

ANALYSIS OF THE SYSTEM

Operating Pressure. A pressure of 20 lb was arrived at as representing the lowest pressure that could be used and insure reasonably uniform pressure at all sprinklers. It seems likely that such systems will be used on reasonably level areas, and that elevation differences which affect sprinkler pressures will not be serious in a line not over 200 or 300 ft long.

Operating at about half the pressure of the standard system reduces the power about half. Reducing the width of the strip irrigated from 80 to 40 ft reduces the amount of water pumped per minute by 50 per cent, and this again cuts the power required by 50 per cent, which means that approximately one-fourth as much power is needed for a line of a given length as compared to the standard system. The reduced capacity permits using 2-in or 3-in tubing, which further reduces the cost.

The No. 1 line, 100 ft long, will cover four acres with one inch of water per week, operating 14 hr per day. No. 2 will cover eight acres, and No. 3, twelve acres. Thus a small, inexpensive system operating nearly continuously does the same work as a standard system operating only part of the time.

The No. 2 system with a sprinkler line 200 ft long, irrigating a strip 40 ft wide, is covering 8000 sq ft, or nearly 1/5 acre. With each sprinkler discharging 4¼ gal per min, one-half inch of water is applied every hour, or 1 in in 2 hr. The line can be moved in 15 min; thus 1/5 acre can be irrigated every 2¼ hr, five runs can be made in less than 12 hr, or six in less than 14 hr. Thus this 200-ft line will irrigate about 1 acre per day, the 100-ft and 300-ft lines, one-half acre and 1½ acres, respectively. Lightweight tubing, 2-in and 3-in sizes, fitted with quick-acting, self-sealing couplings is used.

A thorough search of the field, plus some promotional work, resulted in securing two or three sprinkler heads that would operate very satisfactorily with 20 lb pressure, and that could be sold at a comparatively low cost. These have been given a thorough trial this past season, having been operated in the field for about 180 hr. Measurements indicate that they give reasonably uniform distribution of water, are positive in action, free from operating troubles, and show little or no wear so far.

A National Terrace Classification

(Continued from page 96)

The bench type terrace appears to be the oldest type of terrace that is now being used in connection with the production of agricultural crops. There are the historic bench terraces built by the Incas more than 4,000 years ago, the terraced rice fields of the Philippines started more than 2,000 years ago, the terraced vineyards and fields of the Rhine, the Mediterranean basin of Europe, and in the Orient that are centuries old. In the United States there is evidence that some bench terracing was used by prehistoric Indians in the Southwest to facilitate irrigation, and it is still being used by the Pueblos of New Mexico and the natives of Mexico. The oldest examples of bench terracing by American farmers are probably those found in rolling sections of the southeastern states.

Adaptation. In general, the drainage type terrace appears to be applicable to most terraceable areas in the humid sections of the United States. In these sections rainfall, topography, and soil conditions usually render complete rainfall retention impractical and necessitate the use of a terrace that slowly drains the excess rainfall from the surface of the ground. It may also be said that in general the absorptive type terrace is applicable to the pervious soils and flatter slopes of semiarid sections. Here the total amount of rainfall is less and the soils will permit complete or almost complete rainfall absorption without harmful effects. There are, of course, some exceptions to these general rules, as, for example, the absorptive type terrace can be used with considerable success on certain restricted areas of the sandy eastern coastal plains soils, and a drainage type terrace may be necessary in some of the more humid semiarid sections where steeper slopes or more impervious soil types prevail. Thorough examination of the local soil and rainfall characteristics is essential for the final determination of the most suitable terrace type for any locality. In the adaptation of each type of terrace to different localities it will often be necessary to vary cross-sectional dimensions to facilitate the use of local equipment and cropping practices.

The use of the bench type terrace has been primarily limited to thickly populated countries where economic and topographic conditions necessitate the cultivation of steep slopes. In the United States the population density and scarcity of flat lands do not as yet demand extensive cultivation of steeply sloping lands. Bench terracing will be limited to the few mountainous sections where some steep slope cultivation may be necessary and to hilly lands that are particularly adapted to the production of special crops such as orchard or vineyard fruits. Before the use of bench terraces in any area is considered, a thorough study should be made to determine whether there is adequate justification for cropping the slopes that require this type of treatment.

Designing Farm Buildings for Wind Resistance

By Henry Giese

BELIEVING that a large portion of the waste suffered by farm buildings from windstorms could be economically avoided, the Iowa Mutual Tornado Insurance Association several years ago requested the agricultural engineering section of the Iowa Agricultural Experiment Station to carry on a study of the prevention of wind losses to farm buildings.

The work on this project has been divided into the following parts: Meteorology, loss statistics, field observations, aerodynamics, structural analysis, laboratory tests, and building design.

The tornado, a very rapid whirl of small diameter, is so whimsical and destructive in its action that it does not seem practical to build against it, but fortunately tornadoes are relatively few in number and are destructive over only a small area. Considering an average length in Iowa of about 6 mi and a 1000-ft path, the probability of being struck by a tornado is relatively small. On the other hand, high and apparently straight winds are quite prevalent and do much damage to farm buildings and other farm property.

From Fig. 1, it is apparent that a large percentage of the losses experienced over a 4-yr period were small and trivial in extent, 94 per cent being less than $100 and accounting for 44.4 per cent of the damage. Only 28 losses, or 0.38 per cent, exceeded $1,000 and accounted for $44,035, or 16.9 per cent of the total waste. Eighty losses exceeding $500 each aggregated $78,643 and constituted 1.06 per cent in number but 30.2 per cent of the waste.

Much wind damage resulting from open doors, insecure hinges, decayed trees, and miscellaneous flying debris causes minor losses only. A study of demolished buildings gives a more significant picture with respect to wind-resistive construction. For example, we find that the difference in construction between the barn and house makes the latter almost immune from demolition by wind while many of the former blow away. The greater part of wind damage is the result of poor construction methods.

Fig. 2 gives the average annual loss by demolished buildings for the 4-yr period.

In Iowa the house constitutes about one-half of the total investment in buildings. Therefore, with approximately equal investments involved, there were 113 times as many service buildings destroyed as houses, with almost 40 times the economic loss. It would appear then that, if we can approach the strength of the house in the other buildings, we will save many from going down in the wind.

The third phase of the study related to actual observation in the field of buildings which were damaged by wind, with particular emphasis on buildings not completely demolished. Little evidence remains when the building is completely destroyed, but the weakest link may often be discovered when the building remains partially in place.

A few observations of common weaknesses and suggested improvements are given below. A foundation may be inadequate if it cannot hold a building down as well as up. Winds blowing against a building exert a definite tendency to overturn it. Blowing across the top and away on the leeward side, the normal atmospheric pressure may be considerably reduced on a large portion of the outside. The undiminished atmospheric pressure on the inside upward and leeward may actually lift the building off its foundation, unless it is held by large anchor bolts spaced fairly close together and extending well into the foundation. These bolts will hold the sill in place if large washers are used under the nuts. It may seem a superfluous caution to suggest that care be taken that nuts are screwed on all the bolts; however, several failures have been observed as the result of such an oversight.

The connection between the sill and the wall above it is also critical. Conventional toenailing is very weak. Additional strength can be obtained if vertical siding is used and well nailed to the sill.

The necessity for wall braces can scarcely be overestimated. In most farm buildings horizontal siding is nailed to vertical studs or vertical siding to horizontal girts. Strength in the conventional wall is limited to the bearing value of wood under nails and the ability of the nails to resist bending as the joint is twisted. Very little pressure

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Author: Professor of agricultural engineering, Iowa State College. Fellow A.S.A.E.

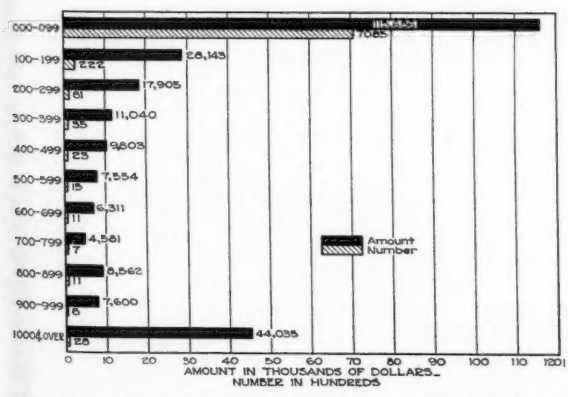


FIG. 1 WIND LOSSES TO FARM BUILDINGS, BY SIZE OF LOSS (AVERAGE 1930-1933, IOWA)

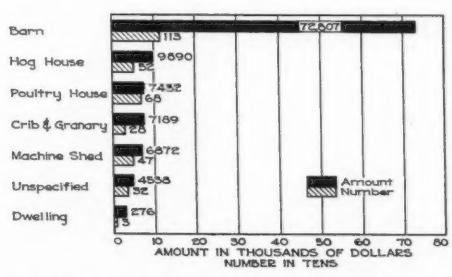


FIG. 2 FARM BUILDINGS DEMOLISHED BY WIND (AVERAGE 1930-1933, IOWA)

(LEFT) MANY BUILDINGS ARE OVERTURNED DUE TO LACK OF ANCHORAGE TO THE FOUNDATION. (CENTER) UNLESS BRACES ARE PROVIDED, HORIZONTALLY SHEATHED WALLS MAY BE DISTORTED BY THE WIND UNTIL THE JOINTS BETWEEN THE SHEATHING BOARDS ARE CLOSED. (RIGHT) NAILS DRIVEN THROUGH THE PLATE INTO ENDS OF STUDS PROVE INEFFECTIVE AGAINST THE LIFTING POWER OF WIND

is required to bend the nails, crush the wood or split the siding boards, and the structure leans until the siding boards are tight together. If it is a barn with small cracks in the siding resulting from the drying out of the boards after placing, the amount of "lean" may be small. A crib with siding boards spaced to permit circulation of air may, in the same wind, be blown down. Either failure is troublesome. Cribs sided diagonally in order to secure the benefits of greater strength and rigidity, remain plumb and true for many years. Diagonal cribbing has not been popular because it requires more labor to saw the ends at an angle and because of the appearance. Studs should be spaced closer together to maintain the same length of span between supports. Rain water enters the crib more readily and will rot the lower ends of the siding more quickly than if laid horizontally. Diagonal siding is not well adapted to the practice of making the upper portion of the crib wall tight and the lower half open.

Braces let into the stud faces diagonally, under sheathing, make a horizontally sheathed wall several times stiffer and stronger. One may secure strength and stiffness in a corn crib by placing the siding diagonally along the driveway walls, away from exposure to the weather and out of sight. Studs along the driveway are also usually placed closer together, taking care of the problem of span between studs.

Suggestions for strengthening walls apply equally well to roofs and floors. So little difference in labor and materials is involved that it seems almost inexcusable to construct a building without adequate bracing.

The improper or inadequate fastening of plates and rafters to the top of a frame wall appears to be one of the most common structural weaknesses permitting destruction of buildings in a high wind. In the most commonly used construction method, rafters are toenailed to a double plate which is nailed to the upper end of the studs. Nails driven parallel to the grain and toenailing are ineffective methods of fastening and should be avoided wherever possible. While satisfactory on the windward side or where the roof is sufficiently heavy to balance the lifting effect of the wind, it is inadequate if the forces on the leeward side of a building are large enough to pull the roof from the wall, and the remainder of the structure fails for lack of support.

Side pressures caused by wind tend to make studding act as beams. If the building is relatively short and wind loads are transmitted to the end walls, the braces at the ends may be sufficiently strong and effective to hold the barn in its original shape. The customary method of notching into the stud to provide a ledge to support the ribband upon which the mow floor rests greatly reduces the strength of the studs, and failure may result from this weakness unless knee braces are added to replace the strength lost. On numerous occasions we have seen barns, strong and intact in all other respects, completely demolished because all studs were broken just below the haymow floor.

Modern types of barn frames provide large haymows free from obstructing timbers. Members are frequently built up from planking to make possible the elimination of many defects which would appear in larger timbers, and also reduce the number of sizes which must be stocked by the local lumberman. These developments will be structurally satisfactory if recommended practices are carefully observed. Particular care must be taken at the joints. Nails, although convenient to use because of the ease of driving, are comparatively ineffective. It is physically impossible to drive a sufficient number of nails into the end of a structural member to make the joint comparable in strength to the timber as a beam or as a brace. Where splitting occurs, what little strength the nail joint had disappears. A few well-placed bolts will return very satisfactory dividends, but still better results can be obtained by the use of timber connectors.

Girders and trusses are often built up of several comparatively thin members. If splicing is necessary to secure timbers of adequate length, care should be taken to stagger joints or even to add an extra piece at the joints. A joint makes a member thus built up only as strong as the unbroken pieces. If two are spliced at one place, the combined strength of three members is no greater than one alone.

Care should be taken to avoid splicing sheathing boards over one rafter or stud. For a barn 32 ft in width, the carpenter purchased siding in 16-ft lengths. How natural it was to use two 16-ft boards on the first, third, and fifth courses and by cutting one in half, stagger the joints by using an 8, a 16, and an 8 on the alternate courses. Thus on three studs, half of the sheathing boards were spliced and the strength of the joint greatly weakened. It would have been just as easy to have cut an occasional board into 4 and 12-ft lengths, respectively, and to have distributed the splices over seven or more studs instead of three. End-matched or "endless" lumber, a recent development, makes possible a still stronger wall. This material is cut in random lengths to avoid defects. Since the ends are tongued and grooved and joints in the sheathing are well supported at the ends as well as the sides, joints are well distributed and usually do not occur over studs or rafters. This also eliminates the splitting which so often results when the board is nailed at the end.

The suggestions given above relate primarily to details of construction which will give added strength and rigidity and reduce the probability of demolition from windstorms. To these may be added some precautions regarding details often overlooked which may save minor damage and indirect losses. *(Continued on page 103)*

Test Results of Metallic Zinc Paint on Galvanized Sheet Metal

By George C. Bartells

AN INFORMAL report on the progress of paint tests made by the American Zinc Institute was given to the Structures Division of this Society about three years ago. Since some of these tests have now been in progress from four to six years, it may be of interest to review the scope of the tests and summarize the results which are in evidence at this time (December 1938).

The primary object of these tests is to determine the suitability of certain types of paints for application to, and the protection of, galvanized metal sheets in various stages of corrosion. Many of the paints used were those which we have found in our field work to be definitely recommended for this purpose and widely used. In all, about seventy-five different combinations of pigments and vehicles were applied in one or two coats to about six hundred sheets on the nine building roofs at the various test sites.

Two of the test sites are located in Illinois, one in the south central part near Donnellson and one in Collinsville in the southwestern part. The first location represents a mild rural exposure, the second a more severe one by reason of the polluted atmosphere resulting from large soft coal consumption. A third test site, located in Picher, Okla., in the zinc mining field, offers a fairly mild exposure condition.

Paints used in the Donnellson tests were applied to the roofs of a group of six buildings on the farm of Raymond Harwood. These galvanized roofs, which had been applied at different times during the years from 1910 to 1928, not only constituted an interesting study on the life of zinc coatings, but also offered a variety of surfaces for the application of paint. Practically all sheet surface conditions, from good zinc coating to bare, rusty base metal, with all intermediate stages of rusting, were included. In some cases all of these conditions might be present on the same sheet, as the pictures taken of the roofs before painting clearly illustrate (Fig. 1).

Paints used in the Collinsville tests in one case were applied to the roof sheets of a garage, and in another to the roof sheets of a storage shed; both buildings were located in the central part of town. The sheets on the garage were badly rusted, with no zinc coating left; those on the storage shed were also rusted, but had some areas of zinc coating remaining.

In the Oklahoma tests the paints were applied to the roof sheets of a small storage shed. These sheets showed considerable alloy layer rust and traces of base metal rust.

Presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 29, 1938.

Author: Field engineer, American Zinc Institute. Mem. A.S.A.E.

FORMULATION OF TEST PAINTS

While a variety of combinations of different pigments and vehicles are included in our tests, this paper will report chiefly on the results obtained from the use of paints containing metallic zinc powder in their pigments. Among the vehicles used were asphalt and coal tar; tung, soybean, linseed and other oils of vegetable origin; fish oil, spar varnish; and phenolic resin.

During the summer of 1938, portions of twenty-two sheets were removed from various roofs at the Harwood farm for service specimens. Parts of all of these were sent to the paint division of the U. S. Bureau of Standards at Washington for exhibit and further study. Close-up photographs were made of all of these and many others at the same time; some of the photographs which show good comparisons and illustrate the difference between failure and good service are included, with explanations, in this report.

The advantages of zine powder paint, or "metallic zinc paint" as it is commonly called, as a protective coating for metal surfaces, although well-known in Europe for upwards of a century, have been relatively unfamiliar even to paint experts in this country. In order to give this paint a practical test on a large scale, the author of this paper has painted a number of buildings in different locations during the past eight years; in every instance excellent results were obtained, thus demonstrating that the paint would serve in this country as favorably as in Europe.

One of these buildings is a barn near Collinsville, Ill., on which the galvanized sheet siding was painted in May 1931, nearly eight years ago, with one coat of this paint. Three gallons were used, giving a coverage of 835 sq ft per gal. Fig. 3 shows the barn as painted and Fig. 4 shows a close-up of sheets on the south side of barn in July 1938. Note that even after over seven years of exposure, the paint film is still in excellent condition.

Observations have also been made on other buildings to which metallic zinc paint has been applied by others. An interesting example is a zinc ore-roaster building. This

FIG. 1 (LEFT) VARIED STAGES OF RUSTING OF ROOFING SHEETS BEFORE APPLICATION OF TEST POINTS. FIG. 2 (RIGHT) APPEARANCE OF ROOF AFTER TEST PAINTS HAVE BEEN APPLIED. EACH PAINT WAS TESTED ON A FULL SHEET OF ROOFING

building, covered with new galvanized sheets, was given two coats of this paint in October 1928 and the condition of the paint film in October 1937 was still good, after nine years of severe industrial exposure.

The comments made in the following paragraphs represent the conclusions derived from a careful study of the performance of the paints while under test. It should be clearly understood that these conclusions refer only to the particular tests described, and that their adoption as of general application is not recommended. However, where conditions are similar to those governing these tests, comparable results can reasonably be expected. The term "failure", as applied to paint tests, may be indefinite or vague. In our own interpretation of the test results, we have taken the first evidence of pinholes of rust breaking the paint film as the criterion for incipient failure. Final failure would be the development of large areas of rust, indicating the paint film to be destroyed to such an extent that it no longer affords protection to the base metal below.

CONCLUSIONS

1 Metallic zinc powder paints of the standard "80-20" pigment (80 per cent zinc powder and 20 per cent zinc oxide, with no inerts), and with various vehicles previously noted, have given excellent service in one-coat applications, under present test conditions. The test periods for these cases have extended up to four years; the test bases were rusty or partly rusty galvanized sheets.

2 When the proportion of zinc powder in the paint is materially less than 80 per cent, the service is less satisfactory, in some cases only two years elapsing before failure occurs. The Institute specifically recommends that only the standard 80-20 formulation be used on galvanized sheets or other zinc or zinc-coated surfaces.

3 Metallic zinc paint, when colored red by the addition of iron oxide, gives satisfactory results in excess of two years, which is as long as the tests of this particular formulation have run to date.

4 When changed to a black color by the addition of carbon black, the service results are not satisfactory as pinholes of rust appear in the second year. Apparently there is some interaction between pigments.

5 Asphalt paints used in one-coat applications have not shown good service results, pinholes starting in the second year, with almost complete failure in three years (see Fig. 6). The admixture of asbestos fiber improved the results.

6 The use of ordinary red oxide of iron as a pigment has not proved satisfactory with any vehicle (Fig. 5). On galvanized sheets that had begun to rust, incipient failure (pinholes of rust) became plainly evident during the second year of exposure.

7 Fish oil, when used as a vehicle with zinc powder paints of standard 80-20 pigment composition, has so far (in two years of test) shown generally good results, but with certain proprietary paints of low pigment weight the service is unsatisfactory.

8 Soybean oil, when used as a vehicle for zinc powder paints of standard 80-20 proportion in 30-60-100 per cent replacements of linseed oil, has given good service through the three years this particular test has progressed (see Fig. 8). When used in certain proprietary paints of low pigment content or low-quality pigment it has shown unsatisfactory results, pinholes of rust being in evidence in less than one year's time.

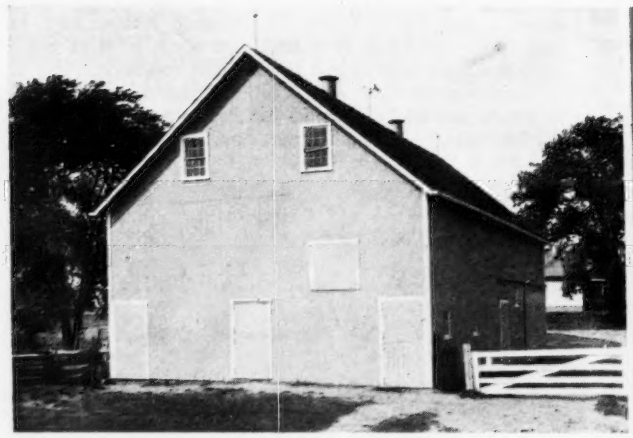
9 Certain commercial varnishes when used as vehicles for 80-20 zinc powder paints do not give as satisfactory service results in rural exposure as does linseed oil.

10 Zinc powder paints without question flow from the brush, spread more easily, possess higher hiding power with one coat and show less of brush or lap marks than any of the other paints tested.

11 The original tests started on the north roof of the granary in 1934 have demonstrated that of all the paints used there, metallic zinc paint of 80-20 formulation, with no inerts, gives better protection in one or two-coat applications than any of the other paints used. In fact, the metallic zinc paint films are the only ones left intact there after more than four years.

12 Certain tests of over three years' duration, and some of less, show definitely that metallic zinc paint with linseed or soybean oil is well adapted to the painting of new, untreated, zinc-coated surfaces. These tests are not comprehensive enough to justify an unqualified recommendation in this respect, but in all cases under observation or actual test the uniformly excellent tight and permanent adherence of metallic zinc paint to such new zinc-coated surfaces indicates a general dependability of the paint for this particular use.

13 All our tests have demonstrated that on sheets where base metal rust is present, one coat of paint does not give adequate proportional protection. Such rusty sheets should, for best results, receive two coats to effectually



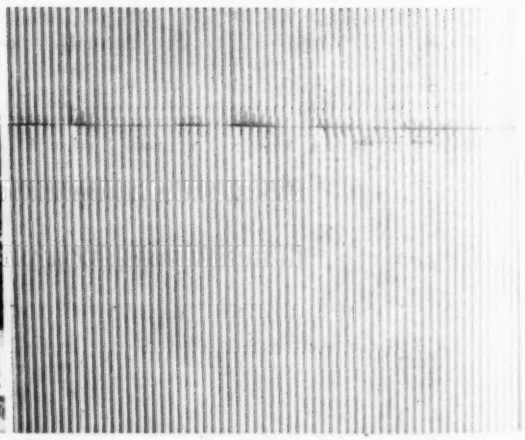
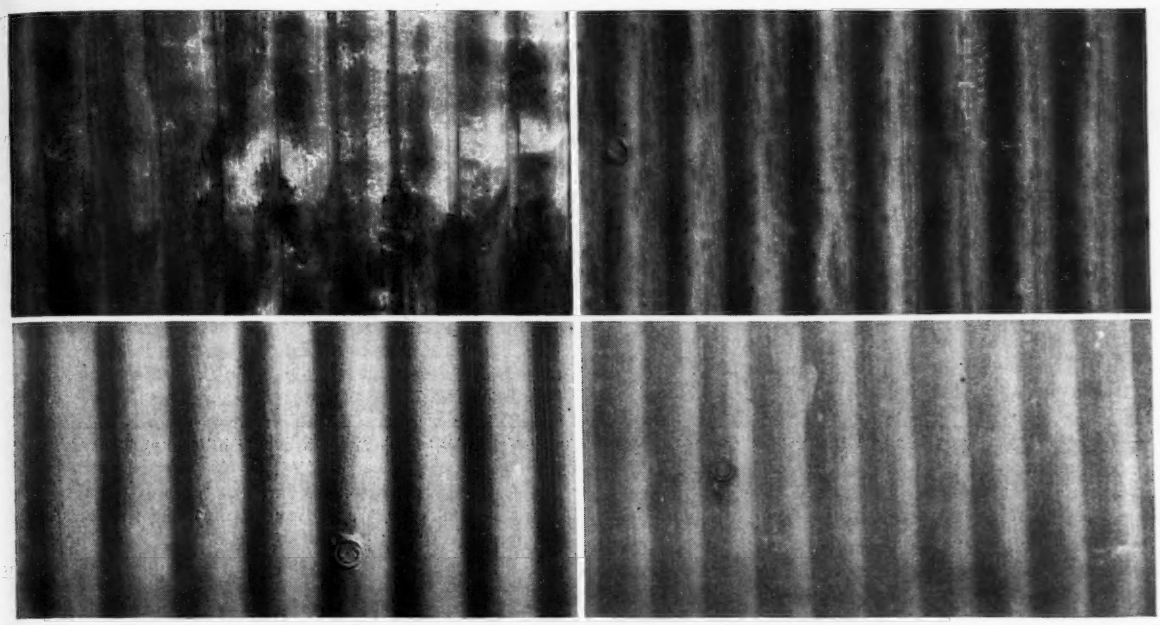


FIG. 3 (LEFT) AFTER SEVEN YEARS OF EXPOSURE THE SINGLE-COAT APPLICATION OF METALLIC ZINC PAINT TO THE METAL SIDING OF THIS BARN WAS STILL IN EXCELLENT CONDITION. FIG. 4 (RIGHT) CLOSE-UP OF SIDING SHOWN IN FIG. 3



SPECIMENS OF PAINTED GALVANIZED SHEETS

Fig. 5 (Upper left) A one-coat application of asphalt paint shows almost complete failure after three years exposure. Fig. 6 (Upper right) One coat of iron oxide and linseed oil, after four years. Fig. 7 (Lower left) Metallic zinc powder in linseed oil, one coat, after four years. Fig. 8 (Lower right) Metallic zinc powder in soybean oil, one coat, after three years. The specimens covered with zinc powder paint are still protected

cover and protect the rough surface of the base metal rust.

14 Paints should be applied to metal surfaces preferably when the air temperature is 60 F (degrees Fahrenheit) or above; otherwise the condensed moisture film likely to form on cold metal will not only be injurious to the paint film but will greatly reduce the spreading rate of the paint.

15 The performance of large-scale field operations indicates that metallic zinc paint of standard 80-20 pigment and linseed oil vehicle can be expected to give at least seven years of satisfactory service in one-coat applications in rural exposures and upwards of ten years of such service with two coats under severe industrial exposure.

Designing Farm Buildings for Wind Resistance

(Continued from page 100)

To a large extent the practical application of the study is made in the laboratory. After field observations disclose certain weaknesses, equipment is designed and constructed to place loads on model structures, similar to those imposed by the wind. Various suggested improvements are tested until a satisfactory solution is secured. Building plans are then revised according to the results obtained.

Acknowledgment is made of the assistance given by Dr. Hugh L. Dryden of the U. S. Bureau of Standards, in interpreting his experiences with pressures on model buildings in wind tunnels, in terms of farm buildings. The flow of air over the roof and past the ends or sides results in a lessening of the static pressures at those points. If the pressure within remains the same, the resultant pressure is outward over a large portion of the building. Open windows on either the windward or leeward side will materially change this situation. Most farm buildings now in use have not been built to withstand these loads. Loadings in tests were imposed in accordance with these principles.

A study was made of the braced-rafter method of barn-roof construction for the purpose of improving the self-supporting roof. Essentially it consisted of a study of methods of fastening and bracing. Tests were made of casein glue joints as well as split and toothed-ring fasteners. Various combinations of braces were tried. As a result of the above, it was found possible to secure much greater strength and rigidity without increasing the amount of material used in the truss.

Since many barns with curved roofs have settled out of shape, an effort has been made to secure satisfactory construction at reasonable cost. Conventional methods of making these rafters have been modified in three respects. The radius of curvature has been increased so that the arch ring more closely follows the resultant of dead loads, making for greater stability and less tendency to settle out of shape due to the weight of the roof itself. Seven laminations of 1x2s have been used instead of five 1x4s, resulting in greater beam depth with less width and less material but increased stiffness. The addition of glue in the joints prevents slippage between laminations. These few illustrations are typical only of possible improvements in construction.

SUMMARY

A study of wind damage to Iowa farm buildings would lead us to believe that structural improvement to make them highly wind resistant is feasible and can be easily accomplished. Little if any more material than is now being used is necessary. The difference in rigidity between the barn and house is sufficient to make the latter practically immune while the former represents the greatest farm loss.

Our first great problem lies in finding better methods of construction and making them available to the public by means of adequate building plans. We must then give consideration to means of distribution and of impressing the builder with the necessity of carefully following details.

Electric Fencing from a Farmer's Point of View

By Harry W. Schilling

JUST AS the invention of the reaper, binder, and later the combine have reduced materially the labor and cost of harvesting grain, so also has the development of electric fencing reduced the labor and expense of keeping cattle in the meadow and out of the corn.

Several years ago I heard of farmers using electric fence, at which time the University of Wisconsin was conducting experiments on the device. I bought one and installed it on my farm, and after experimenting with it, I found it so successful that I spent $35.00 for wire and insulators and built an entire new fence. Then I had the opportunity of accomplishing what I had always hoped to be able to do, that is, divide up my pasture in small lots so that I could get better results from the grass growth.

Since having installed this new fence, it is a simple and economical matter to keep up my entire fence layout. Now in a day's time, with a few insulators in a carpenter's apron, a pair of pliers, and a hammer, I can walk along my entire fence circuit and check up on it. Each year I have more than saved the cost of the fence controller in extra labor alone.

Now after a storm I do not find my cows getting out as a result of a tree blowing over the fence and knocking down several posts. I look at my indicator lamp and know immediately the condition of my entire fence. If my controller lamp shows a short, I check the leads and I then know which direction to go to find the trouble. Usually a couple of new insulators is all that is necessary to repair the damage.

This leads up to a thought of farming by remote control.

You may be interested in a rather unusual use I have found for my electric fence. It is a two-way communication system between the outlying fields and the house. We use two outmoded magneto type telephones, one installed near the controller and the other built into a portable case, and utilize one of the fence lines temporarily disconnected.

I have a strawberry patch located one-half mile from my house. During the strawberry season we find it very convenient to take this portable telephone to the strawberry patch. We then have a direct communication system with the house.

Electric fencing doesn't stop here. Perhaps its greatest asset is that it can be taken up and moved about for temporary fencing, thus simplifying crop and pasture rotation. Now it is easy to fence off the oats stubble for summer and fall pasture or put up a single wire for hogging down corn. Stacks can be fenced off in a hurry. Lanes are quickly built. Gates consist of a piece of wire and a hook or harness strap, insulated from the hand. Other uses suggest themselves, such as exercising pens or a section of pasture fenced off for calves in the spring.

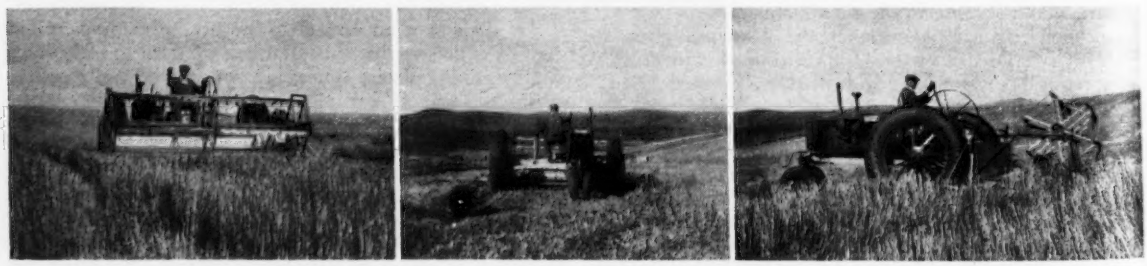
We have been using No. 13 smooth wire exclusively, because it can be bought for half the cost of barbed wire and is much easier to handle. For instance, if we want to move a temporary fence we simply drop the wire from the insulated stakes, put the stakes with the attached insulators in a wagon, attach the end of the wire to the wagon, and drive to the new location with 50, 100, or more rods of smooth wire trailing behind. At the new location we set stakes as we drive along, and when we get to our last stake, the wire is all stretched out in position ready to be attached to the insulators. In less than an hour we can remove and rebuild a fence that would take two or three days of hard labor the old-fashioned way.

However, with all the economy to be gained in electric fencing, much emphasis or credit should be given to a good controller. To fence effectively with smooth wire a high voltage to the fence is quite essential, and furthermore we have found higher voltages essential during extremely dry periods.

But with all the enthusiasm for electric fence, we certainly must not overlook the importance of safety. We have to admit that, living with the fence day in and day out, we are going to come in contact with it, accidentally or otherwise. Naturally we have to depend on some authority to protect us from buying death-dealing devices. Of course, we might increase our insurance policies, or we may even get a policy with our controller but, as someone once said, "An ounce of prevention is worth a pound of cure." It is with this thought in mind that I introduced in the Wisconsin legislature a law authorizing the state industrial commission to set up rules and regulations for electric controllers to render them safe. The commission has now adopted and published such regulations and I am confident other states will follow. Perhaps the National Electric Safety Code will act to unify such regulations throughout the United States.

Presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 1, 1938.

Author: Farmer and state legislator, Wisconsin.



Heading equipment for canning crops such as peas. This push-type header is in the experimental stage of development

Food Preparation and Utilization Aspects of Refrigerated Locker Storages

By Sybil Woodruff

RAPID EXTENSION in Illinois of locker systems for freezer storage of food is probably representative of the increase in their popularity in other midwestern states. Practically all these locker plants in Illinois have been built since 1936, and this fall there are at least sixty in operation, of which almost one-third are cooperatively owned and managed. Their space has been given over very largely to the preservation of meats, in the Midwest, though in northwestern states where they first developed, they have been used for fruits and vegetables to a great degree.

One hears accounts from agricultural extension workers and those who have observed these locker systems in operation, of food wasted by ignorance of proper methods of using this new type of preservation, of instances where whole crates of strawberries have been frozen just as they came in from the farm, of cases where wrong building construction has made adequately low temperatures an impossibility. It is to be expected that mistakes will be made wherever popular interest in a new scheme runs so far ahead of the laboratory's ability to accumulate facts, as has been the case with locker freezing storage. And yet results must have been fairly satisfactory or the system would not have continued to spread. Patrons are apparently finding lockers successful in either one or both of two respects, (a) in reducing the cost of food and (b) in giving food of better quality than would otherwise be possible. Improvement in farm or home food preservation methods is in keeping with one of the recommendations of the "Agricultural Outlook for Illinois for 1938," which was that the farm family continue to produce much of its own food and that it broaden its home-production program to include activities in which labor or distribution costs are an important item of the retail price.

The call upon state experiment stations to help solve some of the problems arising out of the people's effort to store their surpluses of food by freezing, has led to studies such as one which has recently been undertaken at the University of Illinois, a project in which the departments of horticulture, bacteriology, and home economics are cooperating. Fortunately there was already a considerable amount of information on the subject which had come from commercial freezing experience. It should be remembered, however, that commercial development of the frozen food industry has also had an almost mushroom-like growth and has outdistanced the finding of facts in the laboratory. Experience will tell whether freezing can be as successfully practiced on a home scale, making use of locker systems, as is now the case with the commercial frozen pack. It is one of the purposes of the study, to which this paper refers, to obtain some facts which will help answer the question.

In view of the homemaker's interest in the subject of frozen foods, whether of commercial or locker sources, the author has felt impelled to find out how many departments of home economics over the country are making a formal study of the subject. A list compiled in Washington, D. C., of the titles of all current experiment station projects in home economics, shows work to be in progress this year in Oregon, Washington, South Dakota, Illinois, and New York. All except two projects (some states have several) are concerned with vitamin assays of frozen foods. A study at the Minnesota station of the palatability of frozen meats was terminated by the untimely death of Prof. Alice M. Child this past summer. Research in the above or other universities which is devoted to the subject but yet not a part of the experiment station program would of course not be mentioned in the list referred to. Several agricultural experiment stations in their fruit products laboratories, notably in California, Oregon, New York, and Massachusetts, have had studies under way for several years pertaining to vitamin values and technology of commercial freezing practices. Departments of animal husbandry have worked on problems of freezing meats in similar fashion.

It appears easy to justify devoting time to home freezing projects within a home economics department in view of the fact that it seems to be presupposed, at least in this part of the country, that it is the homemaker's responsibility to attend to whatever preparation or pretreatment fruits and vegetables may require for locker freezing. This attitude no doubt arises from the fact that home canning preservation is considered to be "woman's work." The preparation of meats for locker storage is not, however, looked upon as a function of the homemaker, though it comes within her sphere to make whatever adjustments are necessary in methods of cooking frozen meats, as well as in preparing frozen fruits and vegetables for the table.

UTILIZATION OF FREEZER STORED MEATS

Brief mention will be made of some of the laboratory tests which have been reported for the cooking of frozen meats. The most extensive ones have been made in the department of home economics at the University of Minnesota (10)[1] where the amount of press fluid has been taken as a measure of juiciness of cooked meat. A less extensive study of quality was made in the home economics department of the University of Illinois (13) where meats were judged by standard methods already in use by the participants in the cooperative meat investigations of several experiment stations. Results agreeing with those of the Minnesota study showed that juiciness and flavor were not impaired by freezing and did not differ measurably whether the meat was thawed before cooking or not. Meat in good condition when it went into storage, if held at temperatures of 10 F (degrees Fahrenheit) or less, gave good final results and involved no new methods of cooking except for a requirement of longer time if it was cooked without being thawed.

Presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 2, 1938.

Author: Professor of foods, home economics department, University of Illinois.

[1]Numbers in parenthesis indicate references cited at end of paper.

LOCKER FREEZING OF VEGETABLES AND FRUITS

Results of the Illinois study of locker freezing of vegetables and fruits are not yet ready to be reported, though certain facts about the project may appropriately be mentioned in this paper. In this year's work, 700 packages of vegetables and fruits have been stored, of which 425 are of seven different kinds of vegetables, and 275 of seven kinds of fruits. Freezing and storing facilities are being rented from a commercially operated locker system in Champaign. This is making impossible the perfect control of experimental conditions, but, on the other hand, it is acquainting the workers with situations which a farm family will be bound to encounter as space is rented for actual use. All materials are being examined periodically over several months of storage from the standpoint of quality and bacteriological condition.

Containers. Containers of several types are being compared, one of heavy cardboard of the type used in selling ice cream and called "Sealright". Constructed to carry liquids, it is best adapted to packing fruits which usually are covered with sugar syrup. These cartons are cylindrical and unfortunately necessitate a considerable amount of waste space as the locker is filled with them. Rectangular pasteboard cartons which can be purchased in "knocked down" form permit the most economical use of space in the locker. But they require a moisture-proof lining of either cellophane or parchment paper, the fitting of which to the carton is somewhat time consuming. These pasteboard boxes can be used satisfactorily for most kinds of vegetables. Though it would be awkward to do so, both of the two kinds of paper containers might possibly be cleaned and kept for use a second time, in order to save expense. Glass fruit jars are being employed in the study because their use has been recommended by locker plants in order to avoid the expense of purchasing cartons. Glass jars pack to such poor advantage in the locker and offer such a breakage hazard, however, that there is nothing except their availability to recommend their use. Tin cans have much in their favor if a can sealer is accessible, except that they, too, fail to use every available square inch of space in the locker.

Cost of Freezer Storage. The Farm Credit Administration has issued a recent circular (9) on the subject of refrigerated food lockers, in which the estimated average cost of storing meats is given as about 5 cents per pound, including locker cutting and freezing charges. This figure is based on a locker rental charge of $10.00 per year.

In the current study at Illinois, an estimate of the cost of freezing vegetables and fruits has been made. Some indication of the economy of freezer-packing each of the two kinds of pasteboard containers is given in Table 1. The better use of space by the rectangular-shaped ones, of which the locker holds 158 as compared with only 100 of the cylindrical-shaped cartons, is shown by the table. In computing the cost per pound of food thus stored, an assumption was arbitrarily made that fruits and vegetables might be allowed to occupy the locker for 5 mo and meats or other foods the remaining 7 mo. The cost of the rental charge was prorated on this division of time. The annual rental of $14.00 is what is actually charged by the company in Champaign for a locker drawer measuring 30x20x18 in. The purchase price of the sealright ice cream cartons is $23 per thousand and of the rectangular ones $4.79 per thousand. The cost of moisture-proof cellophane lining is more than that of the rectangular box itself; the figure given in the table includes the cost of both box and lining. Continued work may show that the quantities of foods packed in the cartons will need to be changed slightly.

The cost per pound of storing vegetables and fruits, exclusive of the cost of the fresh produce, is a significant figure, from approximately 4 to 7 cents. The extra charge which is usually made for sharp freezing has not been included in this computed cost.

The reward of successful freezer-storage of vegetables and fruits appears from the figures in the table not to be the saving of money. Home canning would undoubtedly be a cheaper method of preserving, though no figures on comparative cost are being offered here. The reward lies in retaining the flavor and color of the stored product in a state more nearly like that of the fresh one. Another possible point of gain is in a saving of effort in freezer storage. It is an impression which workers in the Illinois laboratory have that it is far easier to prepare a bushel of vegetables for freezer-storage than it is to can the product. This impression may be difficult to verify, however.

TABLE 1. COST OF STORING FRUITS AND VEGETABLES IN FREEZER LOCKERS

(Based on locker 30x20x18 in, renting at $14 per year)

	Sealright cylindrical cartons, quart size	Rectangular paper cartons, quart size
No. of cartons held by locker	100	158
Pounds of food in locker	121 (strawberries)	208 (peas)
Cost of cartons	$2.30	$2.08 (cellophane lining included)
Locker rental for 5 months*	5.83	5.83
Total cost	8.13	7.91
Cost per pound of food	.067** (strawberries)	.038** (peas)

*An arbitrarily chosen fraction of the year's rental.

**This cost is exclusive of the cost of the food itself and of the extra charge for sharp freezing.

Safeguarding Flavor and Color. It should be borne in mind that a fresh-vegetable or fresh-fruit flavor or color cannot be secured except by paying strict attention to certain precautionary procedures. Preliminary preparation for freezing has been quite well established for commercial frozen-packs (7, 8, 11), and thus far nothing has been found to indicate that any less care need be taken with locker storages (16). The method consists first of all in using freshly picked vegetables at a proper stage of maturity, then precooking or blanching in boiling water for from 1 to 7 min, depending upon the nature of the material. This partially destroys natural plant enzymes which otherwise would produce oxidative changes during storage, the effect of which is unpalatable, haylike or weedy flavors and off-color. Disregard of the blanching treatment of vegetables is disastrous. These oxidative changes can be reduced to a minimum by satisfactory blanching in combination with holding the frozen food at a low temperature during storage. All experimental results indicate that this temperature should be 5 F or lower (2). It is somewhat doubtful that locker systems as they operate in most places are capable of providing continuous temperatures as low as this. Hence there is a handicap on locker-stored vegetables from the start. The temperature in the locker room which is being used for this study has usually been found to be 12 F or higher.

Oxidation changes in fruits are best slowed down, not by blanching, which substitutes a cooked for a fresh flavor, but by coating the surfaces with sugar syrup which keeps out some of the air. Some fruits, notably raspberries, seem

not to need even this protection. The freezing of fruits should be done with all possible speed, as should also that of vegetables.

Suggestions for Improving Locker Storages. Agricultural engineers who have an interest in the sound development of locker freezing of food, need not be reminded that too much emphasis cannot be placed upon the necessity of constructing plants which will carry temperatures low enough to insure best quality in frozen foods.

Someone with sufficient ingenuity to devise a square-sided, leak-proof, pasteboard carton which can be used equally well for fruits and vegetables, would perform a real service, especially if he could make it to sell at a cost far under that of the ones now available.

A device which would enable the homemaker to label cartons of different kinds of food with distinguishing colors would save her much time in a cold locker room when she is searching for the desired product.

NUTRITIVE VALUE OF FROZEN-PACK FOODS

Several laboratories have engaged in studies of the vitamin content of frozen-pack foods of commerce. Vitamin C has been assayed oftener than the other vitamins and has been found to diminish some in amount during the blanching, cooling, packaging, sealing, and shipping operations, though as one group of investigators has pointed out, equal or greater losses of vitamin C might occur during the usual procedures of marketing and handling the so-called fresh vegetable (3, 6, 15). After the frozen vegetable has been thawed, the vitamin C diminishes progressively with standing. Overblanching causes a loss of vitamin C due to dissolving action of the water; too little blanching may allow for oxidative destruction of this vitamin during storage. One laboratory found 40 per cent of the vitamin originally present in frozen peas, to remain in the cooking water after it had been drained. Hence the quantity of water used in cooking becomes a matter of importance if excessive amounts of it are apt to be discarded before serving.

Other vitamins have been studied less than vitamin C. It has been shown (14) that peas and lima beans lose none of their vitamin G during either freezing or cooking; neither was vitamin B lost in peas during freezing, though 26 per cent of it was lost during cooking. Vitamin A has been found (4) to be unimpaired by commercial freezing of foods.

BACTERIOLOGY OF FROZEN FOODS

The number of bacteria in frozen meats tends to decrease as freezer storage is prolonged, about 84 per cent having been found to have been killed off in hamburg steak under one month's exposure to the unfavorable condition of the frozen state (5). It has furthermore been found that encysted trichinae are destroyed by holding pork for at least 24 hr at a temperature of 0.4 F (1).

Bacteria in fruits and vegetables likewise drop in numbers during freezer storage. This diminution has been found to be as much as 90 per cent of the number originally present. It has been reported to be practically impossible for botulinum poisoning to occur through the use of frozen vegetables and fruits because the toxin is not produced under these conditions of handling until decay has progressed so far that even the least fastidious person would refuse to touch it (12).

Too much emphasis cannot be given the warning to consumers of freezer-stored foods that after thawing has occurred, the food becomes even more perishable than it was before being frozen. The few bacteria which survive can multiply rapidly in the tissues which have been made even more susceptible to spoilage by the physical changes of freezing.

It should be made clear that all the work done so far on the bacteriology of frozen foods has been done with the commercial pack.

In spite of the gaps in available known facts concerning all aspects of frozen-pack foods, the increase in their use and popularity is going on apace. This is true of both locker and commercial storages. It would be of great interest to know whether the patrons of locker systems have felt satisfied with the quality of meats which have been thus preserved, or whether a considerable amount has been thrown away as being unfit for eating. There seems to be too little background of experience and of laboratory findings for it to be said just now whether from the standpoint of economy and quality, rural people in this part of the United States should be encouraged to extend their use of freezing locker systems to preserving their own vegetables and fruits.

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Refrigerated Lockers for Food Storage

By A. A. Geiger

REFRIGERATED locker service is one of the most outstanding recent developments in food preservation for the individual family. It is a service which enables the homemaker to serve each member of her family with an ample supply of palatable food products, varied so that all may have an adequate diet, and at the same time make a saving in food bills.

Most people have the impression that refrigerated locker service is of value primarily for rural families. This has been the case up until the past two years. Now we find urban families using it at a faster rate than the rural families. The household mechanical refrigerator with its small freezing compartment has served to educate these people to the advantages of purchasing in larger quantities to obtain a small reduction in regular retail prices. Now they are learning that they can save more money by purchasing meats, fruits, and vegetables in bulk quantities and at the same time obtain a far superior frozen product when properly processed and frozen at the locker plant, than they can by using the freezing compartment of their home refrigerator in which to freeze and store their purchases.

A typical locker plant consists of a chill room, processing room, freezer, locker room, and customers' lobby. The farmer slaughters his beef and hogs at any time of the year and brings them to the locker plant. The custom butcher tags the carcass with a processing ticket which carries name of patron, weight of carcass, size of cuts, and quantity of meat to be wrapped in each package. The meat is then hung in the chill room until it is properly chilled and aged to improve the flavor and texture; next it is taken to the processing room where the custom butcher cuts it into roasts, chops, steaks, hamburger, etc., according to directions on the processing ticket, and then it is wrapped in special waterproof parchment paper and stamped as to contents, locker number, and date. The packages are now ready for the sharp freezer where the temperature is zero or below. Here the meat remains for twelve hours or more and is permanized for long time storage. This sharp freezing is very essential because it is here that the mold, yeast, and bacteria are killed or stopped and dehydration and oxidation retarded. Lastly the packages are removed to the locker room and placed in the individual lockers, ready at any time the patron comes for them. Each patron has his own key and a master key is retained by the custom butcher.

If any one thing may be deemed responsible for the rapid spread and development of locker service, it is the establishment of a custom butcher. He has much to do with the success or mediocrity of a plant, for it is he who meets the patrons, serves them, and keep them satisfied. He is responsible for the sanitation of the entire plant and allows nothing to be placed in the lockers except what he himself puts there. In this way everything that goes into the lockers is properly chilled, wrapped, and frozen.

From data secured from operating plants installed by our company, we have estimated that the total investment for a complete locker plant, including building, insulation, refrigerating equipment, lockers, and processing equipment, but exclusive of building site, varies from $27.50 to $35.00 per locker. This variation is due to such factors as capacity of plant, building materials used, cost of labor, and regional differences in cost of materials.

In our analysis, we have assumed that the average rural renter will use 800 lb of meat per year and the urban renter 600 lb. We have allowed a processing fee of 1.5 cents per pound and a brokerage charge of 2 cents per pound. This brokerage charge is made only when the supply of meat for the locker is purchased by the custom butcher for the patron.

From data on the gross income and operating costs, it is found that the net return on investment has many variable factors. An average plant can be figured to operate from 80 to 90 per cent rental occupany with 70 per cent rural renters and 30 per cent urban, which will return from 21 to 30 per cent on a 300-capacity plant and 22 to 31 per cent on a 500-capacity plant. In our income per locker in Table 1, no allowance was made for brokerage charges for merchandising frozen fish, fruits, and vegetables to the locker patron. A substantial profit can be made by developing sales on these items; the patrons are continually coming into the plant for their supply of meats, which gives the locker plant owner a splendid opportunity to sell them other frozen food products.

TABLE 1. INCOME PER LOCKER PER YEAR, 300 AND 500-CAPACITY PLANTS

	Rural	Urban
Rental charge	$12.00	$12.00
Processing fees	12.00	9.00
Brokerage fees	2.00	12.00
	$26.00	$33.00

The tremendous advertising of frozen food products has served to create a desire in many locker patrons to store fruits and vegetables in their lockers. This condition makes it necessary to have a zero to 10-deg locker room temperature instead of the customary 15-degree room; a zero-degree room should be maintained if the vegetables are dry packed and a 10-deg room for wet pack.

From the data collected by state agricultural extension workers, the consensus of opinion of these workers is that a locker patron can obtain a higher quality product if the wet pack method is used. This is due to the fact that in the wet pack method the sugar syrup added to fruits and the brine solution to vegetables prevents bacteria formation for a long enough period to permit the housewife to take her packages to the freezer in the locker plant. In the dry pack method it is absolutely essential to have the packages in the freezer within a very short time after packaging, which makes it practically impossible for the average locker renter to achieve a high-quality product using the dry-pack method.

Most locker plants will have urban renters who will store dry-pack fruits and vegetables in their lockers, which will require a zero-degree locker room for long-time preservation, so today we are recommending that locker plant owners be prepared to hold a zero-degree locker room temperature.

The important question in the minds of most business men is "Will the people in my community avail themselves of this service?" From the experiences of over 1300 locker plant owners operating in over half the states of the union, and being used by approximately 500,000 families, this question is answered in the affirmative.

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Author: Manager, refrigerated locker storage division, York Ice Machinery Corp.

Some Carotene, Protein and Fiber Values of Dehydrated Alfalfa Meals

By Virgil Wodicka and Lamar Kishlar

OUTSTANDING progress has been made during the past few years in the development of equipment for dehydrating and in the technique of handling artificially dehydrated forage crops, particularly alfalfa. The last available figures were for 1936, when it was estimated that more than 100,000 tons of dehydrated forage products were produced.

In spite of the fact that large volumes of dehydrated forage products are being produced and consumed each year, there is little information available as to the quality of product which can be produced or the seasonal variations in chemical composition which may be expected.

Three dehydration plants were chosen for this preliminary investigation. These three plants, located at Cozad, Nebraska; Osceola, Arkansas; and Dundee, Michigan, were chosen because the dehydrators and other mechanical equipment at the three plants were substantially the same, because the methods used at all plants were as nearly the same as large-scale production would permit, and because the geographical location of the three plants formed the points of a huge roughly equilateral triangle.

Rotating drum dehydrators of the Arnold type were used at each of the three plants. The dehydrators were identical in size. All burned oil. All were operated exclusively on alfalfa.

During the cutting season, it was the practice to cut, haul, and dehydrate 24 hr per day. Some of the alfalfa was cut and dehydrated at night; some was cut in the day time. Some was cut under a bright hot sun, some was cut in the rain. Thus, irrespective of weather, cutting and dehydrating went on nearly every day. The samples, then, represented a cross-section of the kind of product which can be made under all kinds of weather conditions. It represents good, large-scale production.

The average time between cutting the alfalfa in the field and grinding the dehydrated finished product was 3.7 hr. This time varied from 1 to 6 hr, but a large majority of lots were reported as 4 hr between cutting and grinding.

Samples of the dehydrated finished product were taken mechanically at frequent, regular intervals throughout the day as the alfalfa was being sacked. These samples were thoroughly mixed at 4 pm each day, and, for assay, a one-pound composite sample of the day's production was mailed to St. Louis in a special container each evening. Whenever, in the opinion of the superintendent of a plant, the cutting or drying conditions during the 24-hr period were substantially uniform, only one composite sample was taken for each mill. If, however, in the opinion of the superintendent, the conditions changed during a 24-hr period, as, for example, a change in weather, or a change from one field to another where the stage of growth varied, then one composite sample was taken for each set of conditions encountered. A total of 715 samples were included in this study. These were composite samples representing 99,314 bags, or nearly 5,000 tons of dehydrated alfalfa.

The samples were sent by special delivery to St. Louis, where they arrived the following morning. Except for alfalfa dehydrated on Friday and Saturday, which was assayed on Monday morning, all samples were assayed within 36 hr of the time they were dehydrated.

Carotene was extracted from the sample by a modification of the Peterson-Hughes method. The concentration of the carotene in Skellysolve solution was measured on a photoelectric colorimeter which was frequently calibrated against both a standard beta carotene solution and a Bausch and Lomb spectrophotometer. Determinations of the crude protein and the crude fiber were made by standard A.O.A.C. procedures.

Since each sample represented a lot of alfalfa of variable quantity, there was a question whether an arithmetic mean or a weighted mean, using quantities as weights, should be used in computing average weekly values. It was found that the difference in result between the arithmetic and weighted mean was insignificant and probably

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Authors: Respectively, research chemist and manager of research (Fellow A.S.A.E.), Ralston Purina Co.

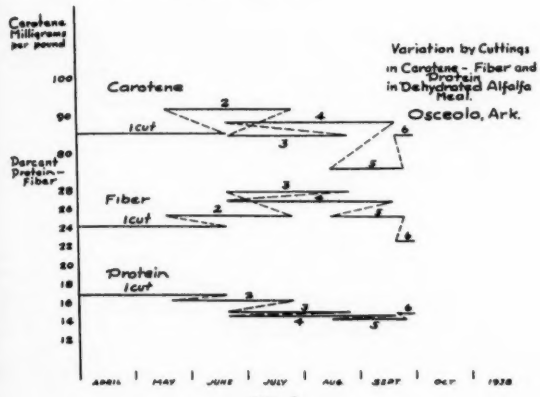

FIG. 1

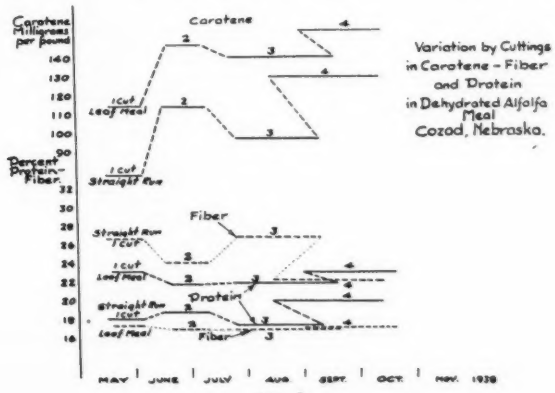

FIG. 2

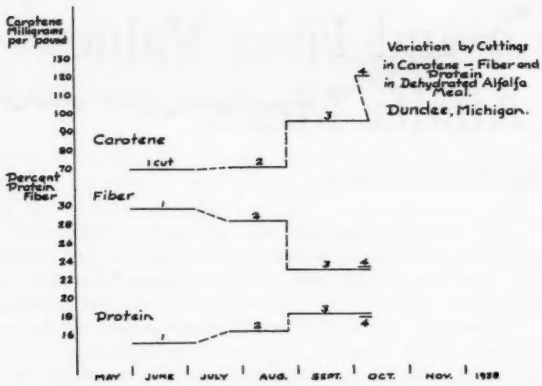

FIG. 3

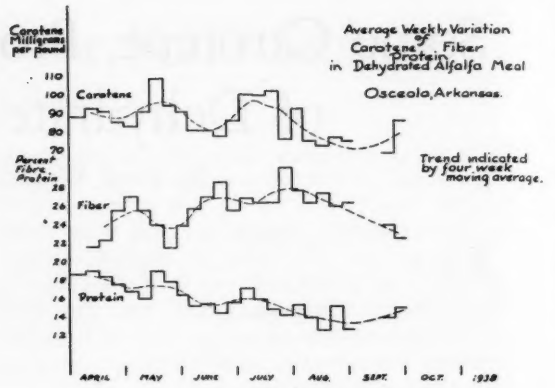

FIG. 4

less than the sampling error. Therefore, arithmetic means were used throughout.

Cutting begins nearly a month earlier in Osceola than in the two northern plants. Fig. 1 shows the variation in mean carotene, fiber, and protein in dehydrated alfalfa by cuttings at Osceola. The average carotene content for the second, fourth, and sixth cuttings exceeded the average carotene content for the first, third, and fifth cuttings. Some cuttings overlap each other in time, due to the fact that frequently the mowing crews would be working on third cuttings in some fields and on fourth cuttings in the other fields during the same week.

The fiber averages by cuttings at Osceola increased through the first, second, and third cuttings, then decreased through the fourth, fifth, and sixth. The protein averages by cuttings declined progressively until the sixth cutting, which showed a slight increase.

At Cozad, Nebraska, the variations in carotene, fiber, and protein showed much the same pattern (Fig. 2), although the season was shorter and only four cuttings were made. Here again the average carotene content for the even-numbered cuttings was greater than for the odd cuttings. Here, too, the protein follows the same pattern, with cuts 2 and 4 exceeding 1 and 3. *(Continued on page 114)*

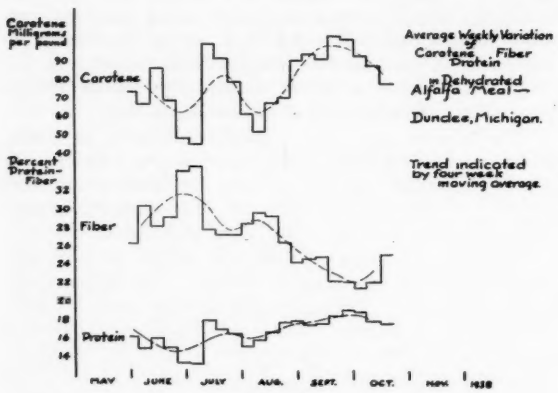

FIG. 5

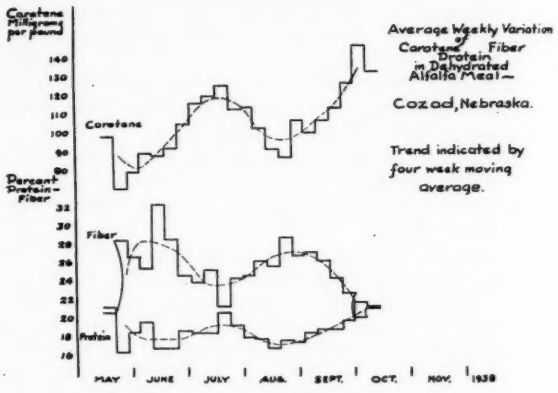

FIG. 6

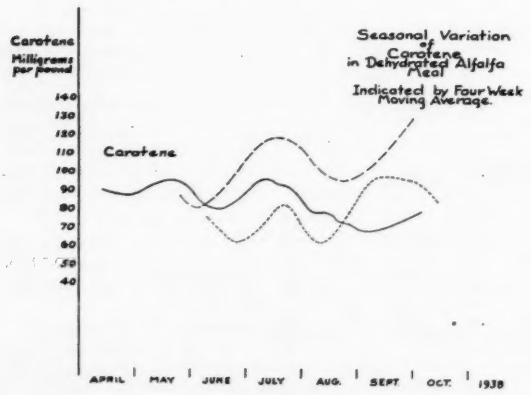

FIG. 7

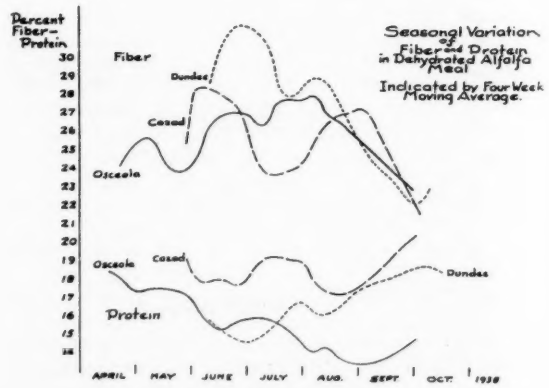

FIG. 8

The Dynamic Properties of Soil

VIII. The Effect of Certain Experimental Plow Shapes and Materials on Scouring in Heavy Clay Soils

By F. A. Kummer

PRECEDING papers of this series (2, 4)* have repeatedly referred to the difficulties encountered during tillage operations on heavy clay soils. It has been pointed out (2) that one of the most pertinent tillage problems of the Southeast is the selection or development of plows which would satisfactorily turn the heavy, plastic soils of the Black Belt of Alabama and Mississippi. Investigations of this type represent an important step in the management of these heavy soils and are part of an extensive program of research in which several agencies are cooperating.

The soils of the Black Belt are similar in character to the waxy soils of Texas which have long been the object of much experimentation to produce better scouring. Bacon (1) cites the interesting fact that moldboards made of plaster of paris and those covered with hog hides proved more successful in Texas soils than any other type of moldboard tried, including those made of steel, iron, glass, brass, and aluminum. He states that the Texas observations must be regarded as conclusive evidence that the shape of the moldboard is not the only factor to be considered, but that the material from which the moldboard is made often contributes more to its successful operation than the shape. It is attempted in this paper to verify further this conclusion on the basis of results obtained from field and laboratory experiments.

Experimental Procedure and Results. In accordance with the research program previously mentioned, studies were made on the relative adhesion of soil to various metals (3). After analyzing the results of these tests, it was decided to subject the most promising metals to trials in the field. Since alloy steels consistently gave the best results during the laboratory tests, a conventional plow moldboard, covered with a stainless steel sheet, was subjected to actual plowing tests under field conditions (Figs. 1 and 2). Even though the alloy-steel covering showed some improvement in scouring over the standard moldboard, it was still not sufficient to overcome the excessive frictional resistance offered by the heavy clays. The action of the soil on this plow and on the standard types of moldboards suggested a possible change in design, because a considerable amount of soil adhered tightly to the lower part of the moldboard and obstructed the movement of the succeeding soil. These observations indicated a possibility of utilizing the excessive frictional resistance produced by the contact of soil and metal to facilitate the movement of the furrow slice rather than obstruct it.

The first plow employing this principle was constructed as follows: The solid moldboard was removed and replaced by an endless canvas belt which rotated on two tapered rollers. The canvas belt, however, proved unsatisfactory because of its extreme flexibility and tendency to "creep" on the rollers. To eliminate this objection, a slat type ensilage cutter chain was installed in place of the canvas belt and the tapered rollers were replaced by straight shafts, bearing two sprockets each, to guide the rotation of the slat chain (Figs. 3 and 4). This arrangement furnished ample proof that the principle of utilizing the friction between the soil and the metal surface to an advantage was sound, and that the friction was sufficient to rotate the chain. The disadvantages of this arrangement, however, were the tendency of the soil to lodge between the links of the chain and the teeth of the sprockets, and the inability of the chain to follow the original curvature of the moldboard.

To overcome this difficulty a third type of moldboard was constructed, making use of a set of eight wooden rollers which rotated in individual bearings (Figs. 5 and 6). The rollers were inserted in such a manner that they approximately reproduced the original curvature of the solid moldboard which they replaced. The rollers were allowed to rotate freely and knife-edged steel scrapes prevented the soil from lodging between them. The performance of this plow was satisfying enough to justify further experimentation with this principle since it should materially decrease the draft of the implement if such a design were mechanically feasible. The construction of a moldboard of this type would be simple and would not require any radical changes from the present design of conventional plow bottoms. While conducting these tests, it was observed that the rather "sticky" soils had very little tendency to adhere to the wooden rollers. It was thought at the time that this tendency was caused solely by the substitution of wood for metal as a contact surface. That was later found, however, to be only partly true; a great part of the successful operation of the wooden rollers must be attributed to the fact that they had been impregnated with linseed oil. As a result of these observations, it was decided to investigate the possibility of using wood to produce better scouring. For simplicity of construction, the steel slats of a slat-bottom plow were replaced with polished wooden slats of the same size and shape (Figs. 7 and 8). The slats were sawed from patterns, steamed, and dried in the desired shapes by clamping them to the original steel slats. In order to minimize warping and splitting of the slats, they were impregnated with hot linseed oil or paraffin after drying. Comparative tests with this plow and a commercial steel-slat bottom were conducted in the field on Houston, Sumter, Vaiden, and Oktibbeha clays with varying moisture contents. The wood-slat bottom produced considerably better scouring than the steel-slat bottom, especially in the higher moisture ranges where the "adhesion-phase friction" was extremely evident. Plowing tests in plastic clays with moisture contents far beyond ordinary plowing ranges still produced

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This is the eighth paper of a series setting forth the results of soil physical studies conducted at the Alabama Agricultural Experiment Station. Parts I to VII appeared in previous issues of AGRICULTURAL ENGINEERING. Released for first publication in AGRICULTURAL ENGINEERING with the permission of the Director of the Alabama Agricultural Experiment Station.

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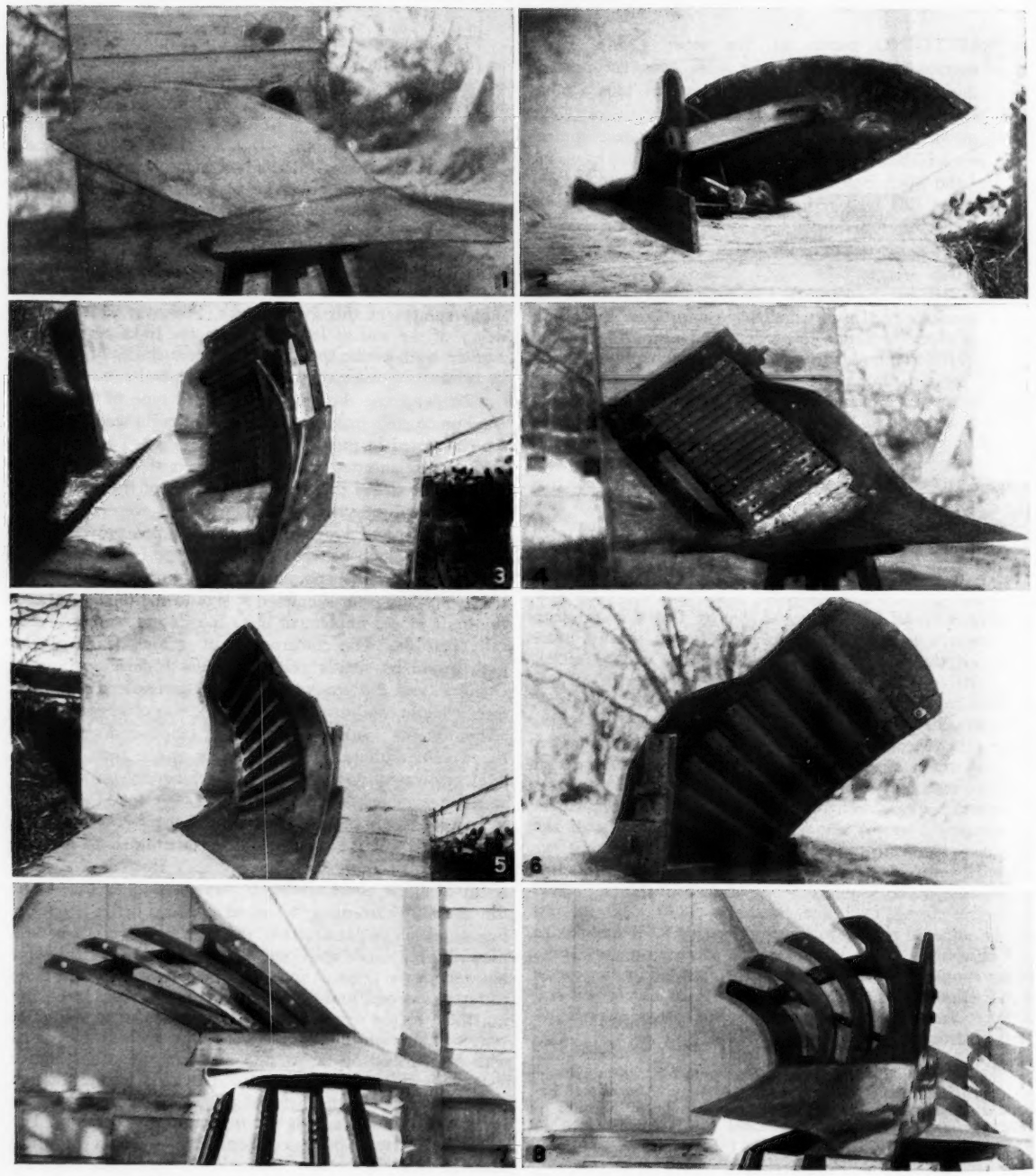
*Numerals in parentheses refer to literature cited at the end of this paper.

satisfactory scouring with very little puddling effect on the soil.

Since the impregnated wooden slats gave rather gratifying results, it was decided to subject them to laboratory tests in order to determine the extent to which various factors contributed to the improved scouring. Two kinds of wood, maple and beech, were chosen and used exclusively in these tests because of their uniform and close-grained structure. Several soft center steel samples were used to provide a basis for comparison between commonly used materials and the impregnated wood surfaces. Table 1 illustrates some striking differences in the magnitudes of the contact angles between water and the different materials. The contact angles were determined by a method published previously (3). Because of the high absorptive properties of the untreated wood surfaces, it was impossible to determine their contact angles. The contact angles for the impregnated wood surfaces, however, exceeded 90



FIGS. 1 AND 2 MOLDBOARD COVERED WITH A SHEET OF STAINLESS STEEL. FIGS. 3 AND 4 MOLDBOARD PARTLY CUT AWAY AND REPLACED WITH SLAT TYPE ENDLESS BELT. FIGS. 5 AND 6 MOLDBOARD WITH WOODEN ROLLERS TO REDUCE SLIDING FRICTION. FIGS. 7 AND 8 IMPREGNATED WOOD-SLAT MOLDBOARDS WHICH GAVE PROMISING RESULTS

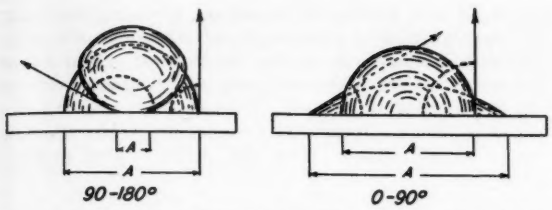


FIG. 9 RELATIONSHIP BETWEEN CONTACT ANGLES AND CONTACT AREAS

degrees and thereby gave evidence of a tendency to repel the moisture rather than to attract it as was the case with untreated wood and steel surfaces. The moisture drops on the impregnated wood surfaces receded from the surface, tending to form individual drops, while on the untreated wood and steel surfaces the moisture drops spread and produced much greater contact areas (Fig. 9).

The results of comparative sliding friction tests between soil and wood or metal surfaces are given in Table 2. The sliders were prepared uniformly in size and were given the same polishing treatment; all sliders were counterweighted to a uniform weight. It was found that under the same conditions considerably less force was required to move the impregnated wood sliders over the soil than was required to pull the steel sliders. The differences between untreated and impregnated wood surfaces were even more significant and must be attributed to the high water absorbing capacity of the untreated wood surfaces. It was possible to reduce the required pull by saturating the untreated surfaces with water, but it must be pointed out that such a procedure would greatly increase the danger of shrinkage and warpage of the wood upon exposure to the atmosphere.

Discussion of Experimental Results. The shapes and materials described in this paper are purely experimental, and it is intended only to present them as suggested avenues of approach. It is fully realized that the various moldboard shapes mentioned in this article have decided disadvantages. Any incorporation of mechanical principles in design is usually done at the expense of simplicity and, therefore, is subject to criticism. It is believed, however, that some of these principles, if properly applied, might prove to be of value in implement design.

TABLE 1. CONTACT ANGLES BETWEEN DISTILLED WATER AND POLISHED STEEL AND WOOD SURFACES.

Sample	Angle in degrees	Description of material	Treatment	Brinell hardness
I. H. C.	78	SAE 1095 S.C.*	None	601
D–1	76	.82 C. S. C.*	"	586
C–2	72	SAE 1095 S.C.*	"	241
M–5	Not measurable	Maple	"	
B–4	" "	Beech	"	
M–2	92	Maple	Linseed oil	
B–2	91	Beech	" "	
M–1	98	Maple	Paraffin	
B–1	96	Beech	"	

*S. C.—soft center steel

The results obtained with the impregnated wooden slats coincide with results from similar experiments conducted on Texas soils where plaster of paris and hoghide coverings for moldboards were used. While the successful operation of the plaster of paris moldboard surfaces can perhaps best be explained as the result of a continuous dissolving and wearing action on the contact surface, the hoghide surfaces are directly comparable to surfaces produced by impregnation with linseed oil or paraffin. These substances are similar to hoghide in their water-repelling qualities, and it is believed that the improved scouring is caused by decreased adhesion of the water to the contact surface.

It has been pointed out in a previous paper (3) that the contact angles between solids and liquids may be of different magnitudes varying from 0 to 180 deg. In cases where the angle of contact between the solid and the liquid is zero, the solid tends to become wetted spontaneously and completely by the liquid with which it is in contact. When the solid-liquid contact angle is between 0 and 90 deg, the force of adhesion is greater than the force of cohesion, and such a liquid will have a tendency to spread upon the solid surface. When a solid-liquid system has a contact angle of exactly 90 deg at equilibrium, the force of adhesion may be said to be equal to the force of cohesion of the liquid molecules. A contact angle greater than 90 deg indicates that the force of adhesion is less than the force of cohesion of the liquid molecules, and in this case a drop of liquid placed on a solid will pull itself together and recede from the solid. This condition is characteristic of mercury in contact with many solid surfaces, and can be approached by bringing water in contact with greased or waxed surfaces. These surfaces prevent spreading of the moisture particles into films and facilitate their formation into individual spherical drops. It has been generally conceded that adhesion between soil and metal is caused by the competition of the soil and plow surface for film moisture (4). Since greased or waxed surfaces, however, do not compete strongly with soil for such moisture, it seems reasonable to believe that the improved scouring of impregnated surfaces is caused by the destruction of the competitive action between the two solids.

It is evident that materials of this kind are not appli-

TABLE 2. COMPARATIVE FRICTION VALUES FOR VARIOUS MATERIALS, INCLUDING SOFT CENTER PLOW STEEL, AND UNTREATED AND IMPREGNATED WOOD SURFACES

(u' = coefficient of friction)

Sample	Brinell hardness	Material	Soil	Per cent Moisture	u'	Soil	Per cent Moisture	u'	Soil	Per cent Moisture	u'	Treatment
IHC	601	0.95 C S. C.	Lufkin	23.4	1.15	Oktibbeha	22.6	1.10	Houston	21.8	1.12	Heat treated
D–1	586	0.82 C S. C.	"	"	1.19	"	"	1.21	"	"	1.17	"
C–2	241	0.95 C S. C.	"	"	1.24	"	"	1.27	"	"	1.23	None
M–5		Maple	"	"	1.33	"	"	1.23	"	"	1.33	None
B–4		Beech	"	"	1.37	"	"	1.28	"	"	1.36	None
M–2		Maple	"	"	0.92	"	"	0.71	"	"	0.86	Linseed oil
B–2		Beech	"	"	0.90	"	"	0.73	"	"	0.83	Linseed oil
M–1		Maple	"	"	0.56	"	"	0.54	"	"	0.52	Paraffin
B–1		Beech	"	"	0.73	"	"	0.60	"	"	0.62	Paraffin

cable to plows used in soils which contain abrasive substances, but since the plastic clays discussed in this paper contain very little sand, the implements used in these soils are rarely subject to excessive wear. Furthermore, no attempt is made to recommend the use of wooden slats as described above, but it appears logical to point out the possibility of using materials which produce similar reactions. In any event it is evident that a strong backing of iron or steel would be necessary to prevent breakage under extreme conditions. Investigations are being conducted at present to determine the value of recently developed plastics derived from resinous substances. These investigations, however, have not been completed and no definite data are as yet available on these materials.

SUMMARY

Results of field and laboratory experiments showing the effect of certain experimental plow shapes and materials on scouring in heavy clays are reported. The equipment and methods used included (a) alloy-steel moldboard coverings, (b) endless belt type moldboards, (c) wooden rollers replacing solid moldboards, (d) wooden slats, impregnated with paraffin or linseed oil, replacing steel slats. The results obtained with impregnated wooden slats coincide with results from similar experiments conducted on Texas soils where plaster of paris and hoghide coverings for moldboards were used. Plowing tests showed that wood-slat bottoms produced considerably better scouring than steel-slat bottoms, especially in the higher moisture ranges.

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Carotene, Protein and Fiber Values of Dehydrated Alfalfa Meals

(Continued from page 110)

Fiber shows the opposite effect, with cuts 2 and 4 lower in fiber than the odd-numbered cuts. On this chart is also shown leaf meal made during the same period. Leaf meal shows nearly the same pattern, excepting for fiber, which is nearly a straight line. This might be expected, since leaf meal is screened to give as close to 18 per cent fiber as possible.

The pattern for Dundee (Fig. 3) is changed slightly, since the carotene averages and protein averages by cuttings progressively increase throughout the season, while the fiber is successively lower.

The variation in carotene, fiber, and protein by weeks tells a more interesting story. Fig. 4 shows the variation for Osceola, Arkansas. The broken line indicates the trend computed as a moving average with a four-week interval. The four-week interval was chosen because it represented the approximate interval between cuttings.

The trend for carotene, fiber, and protein is not a simple curve, but a series of waves. The waves for carotene and protein are in phase. The wave for fiber is in the opposite phase from carotene and protein. Except in late August, these waves do not seem to correlate with weather conditions or temperatures. In late August, there was a severe drought which delayed growth so much that cutting was discontinued for two weeks in September. However, during the period of severe drought and just before the cessation of cutting, the fiber dropped and protein gained. The carotene declined less than in many periods when weather conditions were more nearly normal.

Fig. 5 represents a similar diagram showing variation by weeks at Dundee, Michigan. Again the carotene and protein values vary in waves which are in phase, while the fiber waves are of opposite phase. In September, when cold weather set in, the carotene dropped rapidly.

Cozad, Nebraska, (Fig. 6) shows the same wave-pattern. For each of these widely separated plants, carotene and protein peaks were reached in July and late September irrespective of weather.

It might be expected from the interrelationship of the curves showing the variation of protein, fiber, and carotene with time, that some quantitative statement of this relationship might be derived. In an attempt to study this, correlation coefficients were calculated between protein and carotene, and protein and fiber, respectively, for the entire crop at Osceola. The coefficient relating protein to carotene was found to be 0.60, while that for protein and fiber was found to be –0.35, the minus sign indicating that the line relating fiber to protein has a reverse slope. While these coefficients are statistically significant, they do not indicate as close a relationship as we had expected to find. In making up the correlation tables for this study, however, it was noticed that the samples being scored within any particular short time interval were more closely grouped than the main body of samples. This may indicate that any equation relating carotene or fiber to protein may have to include time as a variable. Further study of these relationships is being made.

Osceola, Arkansas, is approximately 6 deg in latitude south of the other two plants. The sun there is, therefore, approximately 23 days in advance of its position at the two northern plants. But when the carotene trends for all three plants are plotted together, instead of the Osceola carotene trend being advanced 23 days ahead of the other two waves, all three are nearly in phase (Fig. 7).

When the fiber and protein trends are plotted together they are in opposite phase and the peaks in fiber correspond to the dips in protein. The Osceola plant started operation a month before the two northern plants; hence Osceola completed one cycle before the other two plants began operations. When the two northern plants started to cut alfalfa, the three plants showed peaks of high carotene and protein which were in phase. Each plant showed a high peak in July and a high peak in September irrespective of geographical location or local weather conditions.

It is hoped that this work may be carried on for several seasons to find whether these periodic variations in protein, fiber, and carotene can be duplicated, and to find, if possible, what factors govern them.

Natural Drying of Forage Crops

By T. N. Jones

THE agricultural engineering department of the Mississippi Agricultural Experiment Station has for the past seven years conducted fundamental studies in improved field methods of curing hay. Four previous articles have been published on this work[1]. I shall, in this paper, endeavor to bring our findings up to date.

While the studies for the first two or three years dealt mainly with better methods of field handling and preliminary work on crushing, the last several years have been given to a more complete study of crushing and its effects. The principal conditions studied in field handling of hay were (1) in the swath, (2) in single and double windrows raked (a) at time of cutting, (b) 2 hr after cutting, and (c) 4 hr after cutting, and (3) crushed and uncrushed. With the combined efforts of the plant physiologist and the engineer, the physiological and natural changes and effects on the plant of different methods of field handling were measured.

The ideal time for cutting hay is during the forenoon, but it would be impossible for farmers to cut hay only in the morning. However, the farmer should work out his own cutting problem so that the least possible amount of hay be left in the swath over night, as a heavy dew will discolor and damage the hay as much as a light rain.

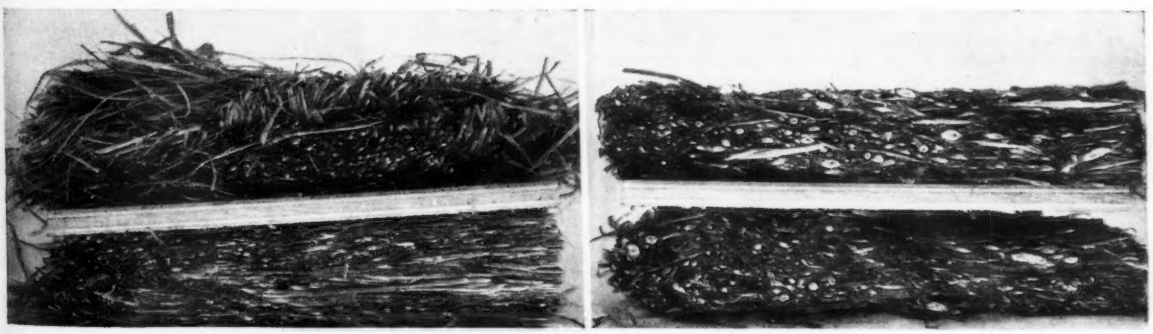
It was found that alfalfa hay should be left in the swath from 2 to 3 hr, depending on the temperature, growth of hay, and soil moisture, after which it should be double-windrowed. By double-windrowing, the hay lost moisture at a more rapid rate than if left in the swath or single windrow. A study of stomatal behavior on alfalfa revealed that the stomata reopen following windrowing, thus allowing for a freer exit of the plant moisture. When the hay is double-windrowed after a 2 or 3 hr period in the swath, the temperature surrounding the leaves inside the windrow gradually falls and the relative humidity rises. Tests showed that the temperature inside the windrow was 5 to 8 C (degrees Centigrade) lower in the double windrow 3 hr after cut than in the swath, while the relative humidity was 10 per cent higher in the double windrow than in the swath, at the same time. A combination of these factors favors a temporary check in the moisture loss from the leaves, sufficient to permit the cell walls bordering the air spaces of the leaf and the stomatal chambers to again reach the saturation point, and for the guard cells to become more turgid and begin reopening. After this takes place, the partially opened stomata, the lower temperature, and higher relative humidity of the air surrounding the leaves tend to keep the leaf functioning somewhat in its natural capacity, so that the water of the stem has a freer outlet for evaporation. Thus the total moisture content of the plant is reduced rather than that of the leaves only, as was true to a great extent in the swath. These factors, in conjunction with reduced light intensity favoring the preservation of chlorophyll and a more uniform drying of stems and leaves favoring the retention of leaves, served as a basis for the recommendation of windrowing. In all cases where the hay was windrowed after a definite period in the swath, there was an increase in the rate of moisture loss over that of the swath, even within the first hour after windrowing (Table 1).

From Table 1 it may be seen that double-windrowing from 2 to 3 hr after cutting gives hay with lowest moisture content at the end of the day, in addition to more leaves, greener color, and better grade.

Quality of Hay. Quality really means feed value, and the feed value of hay is measured by the growth, gains in

TABLE 1. RATE OF NATURAL DRYING ALFALFA HAY CUT FROM 8 TO 9 a.m.

Method of Handling	Per cent moisture					
	As cut	2 hr after cut	4 hr after cut	8 hr after cut	20 hr after cut	25 hr after cut
Swath	70	60	46	26	46	25
Single windrow as cut	70	62	38	21	38	22
Double windrow as cut	70	64	34	26	38	27
Single windrow 2 hr after cut	70	60	40	22	37	22
Double windrow 2 hr after cut	70	60	32	18.5	30	17
Single windrow 4 hr after cut	70	58	43	21	25	21
Double windrow 4 hr after cut	70	58	44	20	30	20.5



(LEFT) JOHNSON GRASS AND (RIGHT) SOYBEANS, UNCRUSHED SAMPLE IN UPPER SECTION, AND CRUSHED SAMPLE IN LOWER SECTION

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 30, 1938.

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[1] AGRICULTURAL ENGINEERING for August 1932, June 1933, June 1934, and October 1936.

weight, and reproductive ability of the animals fed. Some of the important physical factors of quality which can be readily gauged in a practical way are (1) stage of maturity, (2) percentage of leaves, (3) percentage of natural green color, and (4) condition as to soundness. Quality of hay, from the chemical standpoint, refers mainly to its protein, carbohydrate, mineral, and vitamin content. Experiments have shown that the value of protein in a ton of alfalfa hay may vary almost 50 per cent by dates of cutting in reference to maturity.

Leafiness. In high-grade legume hay two-thirds or more of the digestible protein and most of the vitamin A and minerals are in the leaves. Leaves are lost by cutting too late and by improper methods of curing and handling the hay.

Similar tests with Johnson grass showed that by better methods of field handling, the curing time may be greatly reduced. Johnson grass was successfully windrowed when turned several times with the side-delivery rake after it had been windrowed. Raking with a dump rake rather than a side-delivery rake before the hay was cured was not satisfactory, as the hay was in too tight a roll, which prevented proper circulation of air. This caused the temperature in the hay to rise and the humidity to lower, with a great decrease in the rate of evaporation.

It was found that the stems of alfalfa, Johnson grass, and soybeans would lose only 10 to 20 per cent moisture within approximately an 8-hr period when stripped of their leaves as the plants were cut. This result clearly indicates that the leaves offer the most favorable outlet for the plant moisture, and also gives a fairly definite index as to the impervious nature of the stem wall and the resistance offered to the radial passage of moisture out of the stem.

By a study of stomatal behavior through photomicrographs, the outline of stomatal pores and shrinkage of protoplasm within the epidermal cells was shown as dehydration progressed. Results of this work show that at the end of 2 hr in the swath the stomata are practically closed and plasmolysis of the cell content is rapidly advancing. However, when the hay is double-windrowed at the end of this 2-hr period, the stomata reopen causing an increase in the rate of moisture loss following windrowing (Table 1).

The greater part of the plant moisture is lost through the stomata of the leaves. The leaves of alfalfa lose moisture much more rapidly than do the stems when the two are separated and allowed to dry separately, supporting the theory that the leaves are especially adapted to loss of moisture. When the hay remains in the swath, a large percentage of the leaves are exposed to the direct rays of the sun and the moisture loss is much more rapid than the normal renewal of moisture from the stem. Consequently, there is a shortage of moisture in the leaf and as the cell walls bordering on the intercellular air passages become dry the remaining water retreats to the cell cavities, thereby causing the protoplasmic content of the cells to shrink. As this shrinkage occurs, the surface tension of the remaining water increases, while the vapor pressure decreases, thereby resulting in a serious check of evaporation from the leaf. The guard cells begin to lose their rigidity, due to dehydration, and the size of the stomatal pore decreases until almost complete closure results when the water content of the leaf falls below the working margin.

The crushing of hay has proved that this method of curing is satisfactory. The curing time of Johnson grass, soybeans, and peas can be reduced 50 per cent or more by crushing. Johnson grass was successfully crushed in the morning and baled the same afternoon. However, on these tests ideal conditions were encountered. The data show that Johnson grass normally requires about 72 hr for curing, and crushed Johnson grass may be baled after 24 hr

TABLE 2. RATE AT WHICH STOMATA CLOSE IN ALFALFA AFTER CUTTING
(Cutting Made at 9:30 a.m.)

Time-taken	Open, per cent	Partly closed, per cent	Closed, per cent
As cut	63.26	36.74	0.00
1½ hr after cutting	8.00	80.00	12.00
2 hr after cutting	1.20	60.12	38.68
3½ hr after cutting	2.59	85.71	11.70
5½ hr after cutting	3.49	53.91	42.60
6½ hr after cutting	0.34	40.95	58.71

curing, giving at least one grade better hay. The weather records at this station show that during the haying season we receive an average of one rain every three days. Therefore, crushing reduces the weather hazard to a minimum and gives hay with more leaves and better color and quality. There is a distinct difference in the rate of drying between the crushed and uncrushed Johnson grass; our data show that at the end of a 6-hr period the crushed hay contained 12 per cent less moisture than the uncrushed hay.

Soybeans crushed with this combination mower-crusher were sufficiently dry to bale at the end of 48 hr, whereas the uncrushed soybeans were baled 120 hr after cutting. Practically the same results were obtained with pea vine hay. Thus, by crushing the large-stemmed plants, the time of curing may be greatly reduced, and in return a better grade and color, more leaves, and more palatable hay will result. The mower-crusher is driven from the tractor power take-off and requires no additional time or labor.

SUMMARY

1 The practice of windrowing alfalfa hay aids a continuation of the natural physiological process of transpiration, resulting in a greater moisture loss for a day's period.

2 Double-windrowing 2 hr after cutting gives hay with a better color, larger percentage of leaves, and a lower moisture content at the end of the day.

3 Data indicate that the leaves of alfalfa plants aid greatly in lowering the moisture content of the entire plant.

4 Photomicrographs showed a reopening of the stomata following windrowing 2 hr after cut.

5 The process of crushing large-stemmed hays such as Johnson grass and soybeans will permit a needed change in methods and will reduce the time required in curing.

Promoting Professional Unity

MANY of these things that we as engineers want will be possible only if we can make the public conscious of the need for them, make the public conscious that we are here in their midst, . . . that we have no selfish motives, that we are actually working for the public weal.

I say to you that the engineering profession has to take up this task itself of being genuinely professional, that is, of convincing the world that an engineer, although he devotes most of his time to copper and wood and steel and stone and mechanisms and things like that, nevertheless is a professional man and realizes his responsibility for ministering to the public weal.

If the American Engineering Council doesn't unite the profession to accomplish this, at present, no one else will in an organized way. But sooner or later it will be done because it is inevitable. . . they must also improve themselves to the point where they are filled with this professional spirit so that the world will see it. Then, I promise you, engineers will not at any time have reason to complain that the public doesn't turn to them.—Excerpt from concluding remarks of Wm. McClellan, president of American Engineering Council, at all Engineers Dinner, the annual meeting of Council, Washington, D. C., Jan. 13, 1939.


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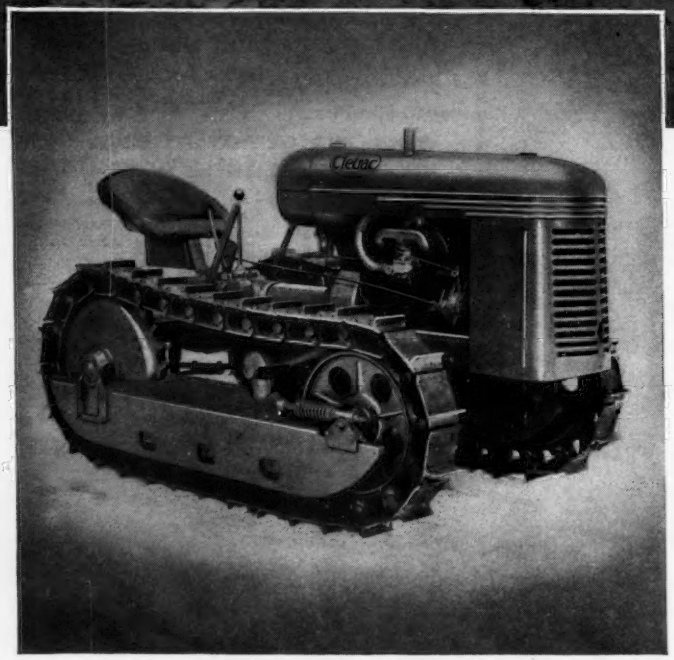
TRACTOR AND IMPLEMENT TIRES

The Cleveland Tractor



POWERFUL YOUNGSTER. The General, newest addition to the Cleveland Tractor Company's family, will pull a 16-inch plow. Under the hood is a high compression gasoline-burning engine, which gives it plenty of power in a little space.

MEET THE GENERAL'S BROTHER. Another new model, the "H," with another powerful, gasoline-burning high compression engine. This model is equipped with Cletrac crawler treads, which have made Cletrac famous the world over.

TUNE IN ON "TUNE-UP TIME" featuring Walter O'Keefe, Andre Kostelanetz' Orchestra . . . Kay Thompson and Rhythm Singers . . . Thursdays . . . Columbia Broadcasting System, 10 p.m., E.S.T.

Company announces its

FIRST WHEELED TRACTOR

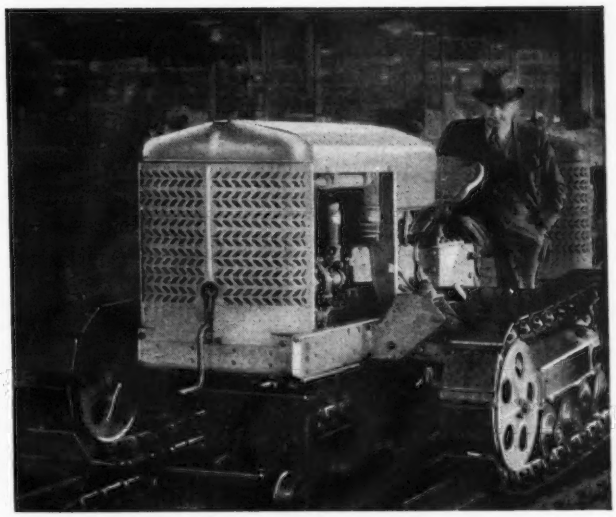
with a high compression engine designed exclusively for good gasoline

THE CLEVELAND TRACTOR COMPANY made another forward stride in the agricultural field when they designed their newest tractor—The General. They made it a row-crop type tractor. They mounted it on rubber. They gave it the job of pulling one plow—but they made that plow a16-inch one. And of course they powered it with a high compression engine designed to burn only good gasoline.

That same type of engine is used in their other two new models, announced at the same time, the "H42" and the "H68." For, ever since they designed their first high compression gasoline-burning model two years ago, the streamlined Cletrac "E," its success with dealers and farmers has convinced them that farmers today want the added power and economy of high compression tractors.

Further evidence comes from a recent survey conducted in 18 leading tractor states, which shows that 7 *out of every 10 farmers* who have thought about buying a new tractor will choose a high compression tractor.

Most tractor dealers have already discovered that it pays to talk, sell and demonstrate high compression tractors. If you don't have all the facts about high compression gasoline-burning tractors, write your blockman or manufacturer today. Remember, too, that even with low compression tractors, good gasoline can increase power, cut oil bills, and improve performance and ease of handling. Ethyl Gasoline Corporation, Chrysler Building, New York, N.Y., manufacturer of anti-knock fluids used by oil companies to improve gasoline.



THIS TRACTOR STARTED IT. Photograph above shows the first streamlined Cletrac "E" coming off the assembly line two years ago. Powered with a high compression gasoline-burning engine, the success of this model led to the use of high compression engines in the three new models now announced by the Cleveland Tractor Company.

What Agricultural Engineers Are Doing

FROM THE JOINT NEWS LETTER OF THE U. S. BUREAU OF CHEMISTRY AND SOILS AND THE BUREAU OF AGRICULTURAL ENGINEERING

AT THE monthly meeting and dinner of the Washington Section of the American Society of Agricultural Engineers on February 15, S. H. McCrory gave an illustrated talk on features of his trip to Europe last fall. He described the flax-processing industry of Ireland and Belgium, the hay driers used in England, and the marsh and sand dune reclamation work of England and Holland.

* * *

Chas. A. Bennett, engineer in charge at the Cotton Ginning Laboratories, Stoneville, Miss., returned from a two weeks trip to Washington where plans for spring activities in ginning and baling were outlined. An allocation of Bankhead-Jones research funds made jointly to the Bureau of Agricultural Economics and the Bureau of Agricultural Engineering for uniform quality in cotton packaging and baling marks the beginning of a very important series of practical investigations with a view to improving the uniformity, quality and appearance of American cotton bales, together with the direct compression of cotton to high density at the gins if this proves to be practicable.

* * *

On February 9 Mr. Bennett, and John W. Wright of the Bureau of Agricultural Economics, made an advisory trip to Dallas, Texas, in connection with the surveys of American compresses which is now under way by a selected staff of economists and technologists.

* * *

A delegation of cotton farmers and ginners from the large plantations of northeastern Louisiana under the leadership of G. A. Gerdes, Louisiana State cotton ginning specialist, visited the Cotton Ginning Laboratories at Stoneville, Miss., on February 13, to obtain firsthand information on cotton gins and improved methods of harvesting and handling. The close cooperation between the Laboratories and the federal and state extension services has had remarkable success in Louisiana during the past two years. The Louisiana extension work is under the direction of Dr. J. W. Bateman, whose staff has built up a great deal of interest in its efforts to improve Louisiana cotton.

* * *

Research tests in ginning the very long staple Sea Island cottons with both saw and roller gins have been under way during the past month. Although it has been contended for many years that saw gins of the Whitney type could not handle the Sea Island cotton, it was found at the Laboratories that the cotton could be ginned but not without considerable loss to the farmer in shortening the staple and causing imperfections and objectionable damage to fiber. The roller gins, which previously used walrus hide covering, have been operating satisfactorily at the Laboratories with a covering made of rubber packing and cotton. New methods of doffing for roller gins developed at the Laboratories are giving promise of improved staple and grade with material benefit to the Sea Island cotton regions of the southeastern states.

* * *

Harry E. Roethe went to Worcester, Mass., on January 6 where he spoke at the Conference on Fire Fighting in the Country. The address which he presented, "Hay Fires that Start Themselves" has created added interest in the subject of spontaneous heating and ignition of farm products. Special interest is being shown in the latest recommendations of the Bureau on practical methods and means of preventing spontaneous heating and ignition of hay, and of handling mows of heating hay.

* * *

With the greatly increased engineering and drafting force fine progress is being made in the Regional Laboratory construction program. An interesting model showing the layout of a unit of the Regional Laboratories has been constructed and is on display in Room 2110-A of the chemical engineering research division.

* * *

A film strip, "Dust Explosion Hazards in Fire Fighting" has been prepared to illustrate hazards that are encountered by firemen when called upon to fight fires in industrial plants.

* * *

A manuscript for a book of "Plans of Farm Buildings for Southern States" has been completed and is now being reviewed by the agricultural colleges of the 12 cooperating states. This book will present attractive sketches of buildings selected by representatives of the state extension services, comprising recommended designs generally applicable to the South. Arrangements have been made for each of the cooperating State Extension Services of the region to furnish to farmers at low cost the working drawings needed for erecting the buildings. This plan book is to be one of a series covering the various regions. One for the northeastern states was issued last year and one for the western states is about to come from the press.

* * *

The survey of farm storage of corn has been broadened to include the noncommercial corn producing areas of the East and South. W. R. Swanson, who has been stationed at Ames, Iowa, is making a trip through corn producing areas in Maryland, Virginia, the Carolinas, Georgia, Alabama, Tennessee, Mississippi, Louisiana, Texas, Arkansas, and Missouri, to obtain data on corn storages. Observations will be made of the suitability of corn storage structures and of the condition of stored corn in these areas. It is expected that Mr. Swanson will return to Washington in April.

* * *

J. B. Townsend, Jr., has been appointed junior architect and reported for duty at Athens, Georgia, on January 23. For the present he will assist J. W. Simons in conducting tests on the experimental houses at Athens.

* * *

J. R. Dodge, members of the staff of the college of agriculture, University of Wisconsin, and the farmers who are cooperating on the farm housing project, assisted J. P. Ditchman, chairman of the rural lighting committee, Illuminating Engineering Society, in obtaining photographs of lighting in the farmhouses that have been remodeled in the farm housing project. Selections from these photographs are to be used for illustrating the bulletin on lighting the farm home being prepared in cooperation with the Bureau of Home Economics and the Illuminating Engineering Society. The manuscript has been completed and is now being circulated among members of the rural lighting committee.

* * *

Wallace Ashby, G. A. Cumings, and J. R. McCalmont attended a conference at New Brunswick, N. J., on February 2 to plan a research program for the coming season to deal with engineering problems in connection with the making and storage of silage from immature grass and forage crops. This is part of a general research program on immature crop silages that is being carried on by the New Jersey Experiment Station in cooperation with the Cornell Experiment Station and others. The conference was attended by representatives of the National Silo Manufacturers Association, the Portland Cement Association, and a manufacturer of phosphoric acid as well as by representatives of the agricultural engineering and dairy departments of Rutgers University and the Bureau of Agricultural Engineering.

The mechanical equipment phase of the project involves power, labor, and performance studies of representative types of harvesting machines and silo filling machinery including choppers, elevators, and preservative feeders. The use of green grass silage, which is a recent practice has imposed a number of new requirements in connection with harvesting and processing machinery, as well as silo construction.

* * *

A. D. Edgar, stationed at Cadillac, Michigan, is making a careful check of the amounts of heat reaching potato storages from the ground and of various heat losses from the storages. These losses are closely related to the control of moisture in the house. At Mr. Edgar's suggestion Mr. Johnson of Edmore, Michigan, installed ceiling drip and drain pans over two bins in his storage house which had been previously wet by drip from the ceiling. This installation has allowed the potatoes to dry and Mr. Johnson reports there is enough water dripping from the corrugated sheets to fill a 10-quart pail each day. Had 10 quarts of water *(Continued on page 124)*

Contributions Invited

All public service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

NEWS

Minnesota Invites You

By Ed. L. Shave

FAR TO the north a land of 11,007 sparkling lakes and 86,000 square miles of forests, streams, and farms awaits your visit next summer.

When the A.S.A.E. annual meeting opens at University Farm in St. Paul June 19, the entire recreational facilities of one of the greatest vacation states in the Union will be at your disposal.

The name "Minnesota" itself means "Land of Sky Blue Water" in the Chippewa Indian tongue, and so far has the state's fame spread that travelers come from half way across the earth to view this "Star of the North."

Fish of every fresh water variety abound in Minnesota's lakes and streams, and to this huge supply of fish life, the state this year is adding nearly two billion newly propagated fish. Game, from the lordly moose to the lowly snowshoe rabbit, roams the broad expanses of wilderness that still remain in Minnesota.

Beaver work nearly every northern stream, protected by law and oblivious to the curious eyes of tourists. To add to the sporting qualities of Minnesota waters, the state's game and fish division has just launched a new venture for propagating muskellunge, the sportiest fresh water fish of them all.

The state boasts 2,500 modernly equipped resorts in 38 separate lake sections. Leading to these from the Twin Cities are 11,500 miles of paved highways, and threading every hamlet and township are 150,000 miles more of county maintained highways.

Minnesota resorts offer facilities to meet every vacation need, from modest housekeeping cabins renting at $10 to $20 a week, on up to luxurious hotel-lodges with private golf courses, excellent chefs and the finest of riding stables.

MINNESOTA'S NORTHERN LAKES PROVIDE SOME OF THE LARGEST AND GAMEST FRESH WATER FISH

The visitor also need not want facilities for other summer sports. There are archery ranges everywhere, and this form of summer recreation has become so popular that a special association has been formed to promote it. The Twin Cities of Minneapolis and St. Paul boast more than a dozen riding stables, and there are others scattered through the state, where one may ride along beautiful woodland trails skirting lake shores.

The Twin Cities, embracing nearly two million people in their trade area, form the largest metropolitan center of the Northwest. There are eighteen lakes within their corporate limits and nearly twice that number of golf courses. Minneapolis has 100 hotels to accommodate visitors and St. Paul about half that number. Churches of every denomination are to be found. Together these two cities form one of the greatest wholesale centers in the nation.

Duluth, gateway to the great "Arrowhead country," is the nation's second largest port in point of tonnage, being exceeded only by New York. Through its excellently protected harbor passes 66 per cent of the nation's iron ore, mined on the Mesabi, Cuyuna, and Vermilion iron ranges in the northern part of the state. On the Mesabi Range one may gaze down into the world's largest open pit iron mine, the great Hull-Rust-Sellers pit, 4½ miles long and 2¼ wide.

At the western extremity of the state lies the fertile Red River Valley, known the country over for its productiveness. And, throughout the southern half of the state, farms in profusion yield some of the heaviest crops of the bountiful Northwest.

In fact, agriculture is Minnesota's biggest industry, producing $358,907,000 cash income from crops and livestock in 1937. Mining follows with a total value of $145,595,000 in 1937. Then comes the Minnesota tourist industry, valued at $80,000,000 last year, when more than 2,000,000 people vacationed in this state.

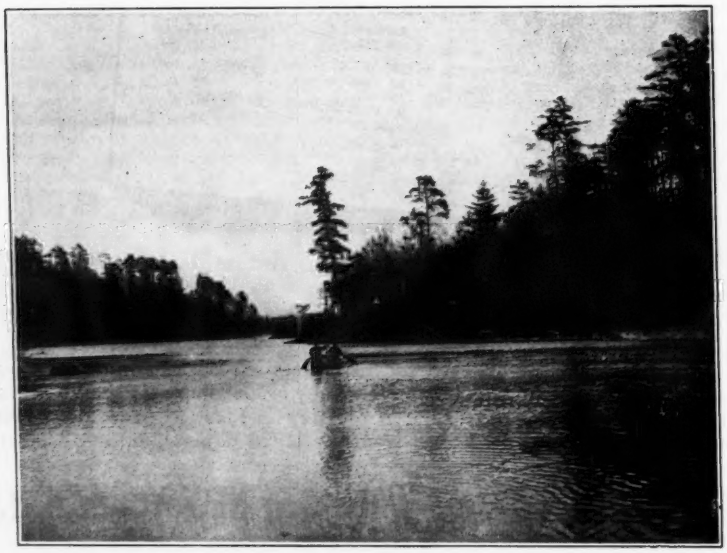
Supplementing the lakes, forests and farms of Minnesota are 27 state parks scattered throughout the area of the state. Most notable of these is Itasca State Park, north of Park Rapids, where the mighty Mississippi rises out of beautiful Lake Itasca. Within this park lives a herd of 2,500 semi-tamed deer, a small herd of buffalo and a number of other show animals.

Altogether more than 17,000 Indians still live on the seven reservations within Minnesota. For the most part they are Chippewas who, in early Minnesota history, drove the Sioux from the land. Many of them still live in birch and cedar bark huts, using the primitive tools handed down to them from generation to generation.

In short, Minnesota is the ideal vacation land, and the Minnesota Tourist Bureau extends you a hearty invitation to avail yourself of its recreational opportunities while you are in St. Paul for the A.S.A.E. meeting.

(News continued on page 124)

Author: Director, Minnesota Tourist Bureau.



MINNESOTA'S 11,007 LAKES COVER ONE FOURTEENTH OF THE AREA OF THE STATE

USING THIS TRACK-TYPE TRACTOR "SPOILS" A FARMER FOR KEEPS!

AN Okla. Diesel D4 owner voices an axiom which hosts of "Caterpillar" track-type Tractor owners live by: "*Once a farmer uses this track-type tractor, it just spoils him for using anything else!*"

For when a man takes this tractor to the field, he gets his work done—without "benefit" of wheel-ballast, mud chains or lug cleaners—without lifting his implements to turn or go through tough spots. This tractor's "every-day shoes" are the equal of any traction condition he meets.

He operates his tractor directly across soft spots and sand pockets, keeps his lands and rows straight, unafraid of getting stuck. He finds what it means to farm without marking or compacting his soil. He proves for sure that heavy-duty drawbar pull assured by unfailing traction is the real essence of speed.

And the man who farms with a "Caterpillar" Diesel Tractor knows the unwisdom of tolerating a fuel bill three to four times as large as his. He's been "spoiled" by fundamentals!

CATERPILLAR

REG. U.S. PAT. OFF.

TRACTOR CO. • PEORIA, ILLINOIS

DIESEL ENGINES TRACK-TYPE TRACTORS TERRACERS

Fifth Annual National Farm Chemurgic Conference

PREPARATIONS for the Fifth Annual National Farm Chemurgic Conference to be held at Jackson, Mississippi, March 29 through April 1 are well under way.

Besides three days of meetings to discuss a variety of chemurgic topics, a final day will be devoted to giving those who attend the conference a chance to visit the sweet potato starch and Masonite plants at Laurel, Mississippi, the community that boasts of being "America's 100 per cent Chemurgic City."

What Agricultural Engineers Are Doing

(Continued from page 120)

been removed by ventilation it would have removed approximately 20,000 Btu of heat per day instead of possibly 400 removed when the pail is dumped. Mr. Edgar was on the Farmers' Week program at Michigan State College January 30 to February 3, for a discussion of potato storage problems. He exhibited a working model to show the effect of design and construction of a potato storage on the phenomenon of condensation of moisture on the wall and ceiling surfaces. He estimates that the model was viewed by at least 1,000 farmers and that he discussed potato storage problems with more than 200.

* * *

On February 4 S. H. McCrory and R. B. Gray conferred at Denver, Colo., with N. R. McCreery, manager, Great Western Sugar Company of Denver, member of the U. S. Sugar Beet Association Advisory Committee, on Sugar-Beet Machinery Development; H. B. Walker, head of the agricultural engineering department of the University of California, and E. M. Mervine, leader of the Bureau's sugar-beet machinery project, relative to future plans for this project. The development of a practical sugar-beet harvester is the major need at the present time although the problems of protection of beets from sugar loss while in the dumps awaiting processing, the refinement of single seed-ball planters, and blocking and thinning equipment are important. Considerable progress has already been made with the harvester, and the two types of planter developed by the Bureau show considerable promise. The use of a satisfactory single seed-ball planter will be of great assistance in blocking and thinning. A cross blocker has already been developed by the Bureau, but some interest by growers appears to be manifested in the row blocker development.

* * *

E. M. Dieffenbach, in cooperation with the Agronomy and Soils Department, Utah Agricultural Experiment Station, has prepared plans and estimates for a number of units for sand culture. If constructed the units will be used by the Station for growth studies to determine the best time interval for cutting back perennial weeds to use up their root reserves.

* * *

Geo. P. Wolf, former business manager of the Bureau of Agricultural Engineering, was transferred on January 16, 1939, to the position of business manager of the Eastern Regional Research Laboratory, Bureau of Chemistry and Soils, where he will serve as assistant to the Director of the Laboratory on all activities relating to personnel, accounts, property, correspondence, etc. Mr. Wolf left Washington on February 7 to establish temporary headquarters at Wyndmoor, Pa., where the Eastern Regional Research Laboratory will be located.

* * *

In the cotton production machinery project arrangements have been made for carrying on field tests of cotton planting methods, seedbed preparation methods and legume coverage methods in cooperation with the Alabama Experiment Station. As much of this work as possible will be done on Experiment Station Farms.

* * *

A series of plot plantings has been put in with four, single-seed-ball, sugar-beet planters and with two conventional planters on the University Farm at Davis, Calif. A set of strip plantings has also been put in with the chain-feed, single-seed planters on a commercial field which will be mechanically cross blocked and carried through to harvest without being finger-thinned to singles. A large part of the commercial sugar-beet fields are already planted in that district, the planting started around January 9, which is somewhat earlier than usual and two to three months ahead of the majority of last year's plantings.

Authors

Eugene G. McKibben is senior author of "Changes in Farm Power and Equipment—Tractors, Trucks, and Automobiles," published by the Works Progress Administration as National Research Project Report No. A-9.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the February issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

John A. Allis, associate hydraulic engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 238, Hastings, Nebr.

Luke B. Biggs, superintendent, tractor assembly department, Fate-Root-Heath Company, Plymouth, Ohio. (Mail) 20 Mills Avenue.

Dale I. Cronkhite, engineer, David Bradley Manufacturing Works. (Mail) 366 So. Dearborn Avenue, Kankakee, Ill.

G. D. Kite, assistant agricultural engineer, extension division, agricultural engineering department, Virginia Polytechnic Institute, Blacksburg, Va.

W. C. Manville, sales engineer, automotive division, U. S. Rubber Company. (Mail) 440 West Washington Street, Chicago, Ill.

William O. Ree, assistant hydraulic engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 312, Spartanburg, S. C.

TRANSFER OF GRADE

Russell C. Proctor, salesman, Staline, Incorporated. (Mail) Box 67, Oxford, Mass. (Associate to Member)

ASAE Meetings Calendar

June 19-22, 1939—Annual meeting, University Farm, St. Paul, Minn.

International Congress of Agricultural Engineering

ANNOUNCEMENT is made of the holding of the next International Congress of Agricultural Engineering at Rome, Italy, September 20-23, 1939. The secretary general of the Congress is Professor Andre Cravino, whose address is Via Regina Elena 86, Rome. No information regarding the program to be presented has been received as this issue goes to press.

Student Branch News

OHIO

AT Ohio State the Student Branch of the A.S.A.E. won a plaque for the first prize booth at the All-Ag Jamboree held January 21 on the Campus. The judging was on the basis of 50 per cent for originality, 25 per cent for appearance, and 25 per cent for effort.

The apparatus was a generator operated by pedaling a bicycle. The current generated enters an induction coil setting up a magnetic field which pulls a soft iron core through the coil. A cord is attached to the core, passes around the pointer shaft and has a small weight on the other end. The pointer stops at a position relative to the amount of power the cyclist is putting out. If he succeeds in putting the pointer or hand completely around it closes a circuit through three dry cells and an electromagnet. The magnetic field setup about the the coil pulls a catch allowing a weight to fall which rings a bell. In the circuit between the generator and the mechanism described previously there are switches, incandescent light bulbs and a watt-hour meter. The maximum output among the better pedalers was about 200 watts, and they were able to maintain this only a few seconds.

If a man were able to maintain an average output equal to one-half his maximum output (which he would be unable to do), at the rate of 5 cents per Kilowatt hour he would have to pedal 10 hr to produce 5 cents worth of electric power. This is a simple illustration of how hard a man would have to work to compete with electricity.

Our outstanding enterprise of the year, our Annual Farmers' Week lunch counter, surpassed all other years in sales and profits. The total sales were $1218.36, an increase of 20 per cent over last year, and the profits were $450, an increase of 40 per cent. The equipment was completely rearranged to increase the efficiency and capacity to meet the demands of our growing business.

The Engineers' Prom sponsored jointly by various departments of the Engineering College and the A.S.A.E. student branch, cleared approximately $80.

At our last meeting, February 16, Prof. G. W. McCuen read a letter to the group from one of the major implement companies, emphasizing the values of the various phases of engineering to a man going into the field of agricultural engineering.

C. O. Reed gave a "thank you" speech for the pipe presented to him by the Branch during his recent illness. He commented on the good scientific selection, in that the pipe had no "side-draft."

The Branch is planning a four-day inspection tour of the TVA during spring vacation. Approximately $200 of the lunch counter profits are to be used to partially finance the trip.—*Charles B. Peak, Publications Committee.*

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers thereof, whose names and addresses may be obtained on request to AGRICULTURAL ENGINEERING, St. Joseph, Michigan

TECHNICAL CHARACTERISTICS OF ALCOHOL-GASOLINE BLENDS. Amer. Petrol. Inst., Motor Fuel Facts Ser. 1 (1938), pp. 15. The purpose of this article is to compare the properties of alcohol-gasoline blends with those of gasoline.

It is pointed out that alcohol-gasoline blends will show little change in mileage but diminished performance without engine adjustments. After engine adjustment similar performance is produced but with definitely reduced mileage. A very slight increase in maximum power output is produced but at the cost of considerably increased fuel consumption. There is less tendency to engine knock, at greater cost, than with other antiknock agents. These fuels have about the same starting quality but more danger of vapor lock. There is no important difference in engine maintenance costs, and no change in the hazard from carbon monoxide in exhaust gases. There is substantial possibility of trouble from separation in tanks and carburetors by water.

EROSION CONTROL AND GROUND WATER CONSERVATION INVESTIGATIONS BY THE WISCONSIN STATION. (Coop. U. S. D. A.). Wisconsin Sta. Bul. 440 (1938), pp. 87-90, figs. 2. Progress results are briefly reported by O. E. Hays, indicating that soil conservation practices maintain crop returns; and by H. F. Scholz to the effect that woodlands with a good supply of litter on the ground absorb enough moisture to add appreciably to the supply of ground water.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE PUERTO RICO COLLEGE STATION, *M. L. Vincente*. Puerto Rico. Col. Sta. Rpt. 1937, pp. 144, 145. Progress results are briefly presented of investigations on traction in different soils using oxen, and on relative efficiency of terraces in soil erosion prevention.

TERRACING, AN IMPORTANT STEP IN EROSION CONTROL, *M. Clark and J. C. Wooley*. Missouri Sta. Bul. 400 (1938), pp. 47, figs. 22. This bulletin gives practical information on the type of terraces for erosion control best adapted to Missouri conditions. It is pointed out that the terrace best suited to agriculture in Missouri consists of a combination of a ridge of soil and a channel built sufficiently wide, on moderate slopes, to be crossed easily with farm implements. It is constructed by placing earth above the ground line in a ridge at right angles to the land slope, with most of the earth taken from a broad channel cut on the uphill edge of the ridge. Terraces are spaced on the slope so as to prevent excessive soil movement between them where a good supply of organic matter is kept in the soil. It must be built with sufficient height to prevent run-off water overtopping it, and given just enough grade in the channel to allow excess runoff water to flow from the field at a nonscouring velocity.

MODERNIZING COTTON GINS, *C. A. Bennett, T. L. Baggette, and F. L. Gerdes*. U. S. Dept. Agr., Farmers' Bul. 1802 (1938), pp. II + 52, figs. 41. Practical information is presented on methods and cost of modernizing gin machinery.

STUDIES OF POTATO STORAGE HOUSES IN MAINE, *A. D. Edgar*. (Coop. Maine Expt. Sta. et al.) U. S. Dept. Agr., Tech. Bul. 615 (1938), pp. 47, figs. 29. Studies are reported the purpose of which was to determine the most satisfactory storage conditions for potatoes in the colder regions of the United States and to develop durable structures in which desirable storage conditions can be maintained with a minimum of attention. An effort also was made to develop a system of handling potatoes in the houses to decrease labor requirements and reduce injury to the potatoes.

It was found that potatoes stored at 40 F and at a uniform relative humidity have a uniform rate of shrinkage between the thirtieth and the two-hundred and tenth day, which is about half the rate for the first 30 days. Holding potatoes for the first 2 weeks of storage at temperatures of from 56 to 60 F decreases shrinkage to about 20 per cent below average, while holding during the early period between 40 and 46 F increases shrinkage to 20 per cent above average. Within the range of temperature and humidities studied potato shrinkage increases uniformly with increases in saturation deficit. Condensation of moisture in the wall-circulation space has been an unrecognized factor in the control of storage conditions and a recognized factor in building depreciation. Such condensation tends to make storage temperatures uniform and removes moisture from the air automatically, and if waterproof wall-circulation surfaces are provided will not increase the building depreciation rate. Walls and ceilings having high insulation resistance permit the carrying of high relative humidities, while high relative humidities cannot be carried where wall and ceiling-insulation resistance is low. Day ventilation (warmer outside air) tends to remove more moisture for a given amount of heat, so is desirable in the winter when there is little heat to spare. Night ventilation (colder outside air) tends to remove less moisture for a given amount of heat, so is desirable for fall or spring ventilation when potatoes must be cooled by ventilation. Limiting wall-insulating values are reached when the necessity of removing surplus heat by ventilation results in lower humidities than would be obtained with a lower insulating value.

WIRING THE FARMSTEAD, *F. C. Fenton and H. E. Stover*. Kans. State Col. Ext. Bul. 63, rev. (1938), pp. 52, figs. 42. This is a revision of a bulletin which brings up-to-date practical information on the wiring of farm buildings and equipment for electrical service, all of which is presented in accordance with the National Board of Fire Underwriters Code.

SURFACE RUNOFF AND EROSION ON GRANITIC MOUNTAIN SOILS OF IDAHO AS INFLUENCED BY RANGE COVER, SOIL DISTURBANCE, SLOPE, AND PRECIPITATION INTENSITY, *G. W. Craddock and C. K. Pearse*. U. S. Dept. Agr. Circ. 482 (1938), pp. 24, figs. 8. This report presents an analysis of data collected during studies of four important herbaceous range cover types with reference to their relative effectiveness in controlling runoff and erosion under conditions of soil disturbance, slope, and rainfall intensity. In these studies a specially designed rain-making apparatus was employed.

The superiority of the wheatgrass range cover for controlling runoff and erosion was considered to be the most striking result of the study. This type of range yielded practically no runoff or eroded material as compared to an average runoff of 45.4 per cent and amount of eroded material of 3.69 tons per acre on the other three types of ranges studied. Moreover, the wheatgrass cover was equally effective under all conditions, on 40 per cent as well as 30 per cent slopes when subjected to either high or moderately heavy rainfall intensities and when the soil was thoroughly disturbed to simulate trampling by grazing animals, or left undisturbed.

Although much less effective than wheatgrass, downy chess range which yielded on the average only 25.5 per cent runoff and 1.05 tons of eroded soil per acre was about twice as effective for controlling runoff as lupine-needlegrass and annual weed cover types, and from two to seven times more efficient in preventing erosion.

In the lupine-needlegrass type, high-intensity rainfall is destructive, and even storms of moderate intensity cause dangerously large amounts of runoff and erosion. This range type is considered to be highly ineffective and undesirable for watershed protection.

DROUGHT OF 1936 WITH DISCUSSION ON THE SIGNIFICANCE OF DROUGHT IN RELATION TO CLIMATE, *J. C. Hoyt*. U. S. Geol. Survey, Water Supply Paper 820 (1938), pp. IV + 62, pls. 2, figs. 18. The conditions of the drought occurring during 1936 are described in this report, together with the presentation of information on effects of drought on ground and surface water supplies and damage.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE MISSOURI STATION. Missouri Sta. Bul. 397 (1938), pp. 49-52, figs. 2. The progress results are briefly presented of investigations on the durability of fence posts, contour furrowing for pastures, erosion control structures, improvement of farm homes, and rural electrification.

(Continued on page 128)

Agricultural Engineering Digest

(Continued from page 126)

THE FOREST PRODUCTS LABORATORY. U. S. Dept. Agr., Misc. Pub. 306 (1938), pp. [2] + 33, figs. 44. A brief account is given of the work and objectives of the Forest Products Laboratory of the Forest Service.

RELATION OF PERMEABILITY TO MOISTURE AND DURABILITY OF PAINT SYSTEMS, *W. W. Kittelberger.* Indus. and Engin. Chem., 30 (1938), No. 3, pp. 328-333, figs. 7. In an investigation of the possible relation between the permeability to moisture and the durability of various priming and three-coat painting systems on wood, it was found that the initial permeability to moisture alone cannot be considered as a criterion of the protection rendered by such a system on prolonged exposure. The permeability to moisture of the ordinary multicoat paint system is low and when weathered was found not to increase appreciably until breaks in the film enabled moisture to enter the wood.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE PENNSYLVANIA STATION. Pennsylvania Sta. Bul. 360 (1938), pp. 28, 29, 38-40, fig. 1. Progress results are briefly presented of investigations on the mechanical dehydration of hay, and on soil conservation (coop. U.S.D.A.).

Literature Received

REFRIGERATING DATA BOOK, David L. Fiske, editor-in-chief. Fourth edition, 527 + 134 pages, 6¾ x 9¼ in. A reference work on refrigerating, heat and power engineering, air conditioning, and domestic-commercial refrigeration and refrigeration applications. Sections cover principles, refrigerants, heat flow and insulation, air conditioning, foods, domestic-commercial machinery, industrial machinery, and control and power. Indexed. Also includes catalog section, directory of distributors, and A.S.R.E. membership directory. American Society of Refrigerating Engineers, 37 West 39th St., New York, N. Y. $4.00 in U.S.A., $4.50 elsewhere.

CHANGES IN FARM POWER AND EQUIPMENT—TRUCKS, TRACTORS, AND AUTOMOBILES, by Eugene G. McKibben and R. Austin Griffin. Report No. A-9, paper bound, XV + 114 pages, 7 x 10 in. This National Research Project study reports on development and improvement of the tractor, adoption of the farm tractor since 1909, principal effects of the farm tractor, development and adoption of farm trucks and automobiles, effects of trucks and automobiles on farm labor requirements and on transportation utilized, and shifts in employment caused by farm tractors, trucks, and automobiles. Publications Section, Division of Information, Works Progress Administration. No price stated.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

ASSISTANT AGRICULTURAL ENGINEER with farm experience and good basic engineering and agricultural training wanted for work with missionary college in India. Young, adaptable man preferred. Must have missionary purpose as well as technical training. Minimum technical qualification is bachelor of science degree in agricultural engineering. Master's degree highly desirable. Appointee without advanced degree must expect to get it during first furlough. General interest in all phases of agricultural engineering preferred to high degree of specialization. Duties mainly teaching. Ability to cooperate with other members of staff, and to use English language correctly is important. Interested persons should apply to the Candidate Department, Board of Foreign Missions, 156 Fifth Ave., New York City.

POSITIONS WANTED

AGRICULTURAL ENGINEER, graduate of Virginia Polytechnic Institute, desires employment where past experience will be of value in future work. Has farm background, two years' experience as an assistant county agent in soil conservation, and engineer in charge of a terracing unit. Has had considerable experience in contacting and working with farmers. Past experience mainly with extension division work, machinery, and erosion control practices. Can furnish best of references. Age 24. Single. PW-301